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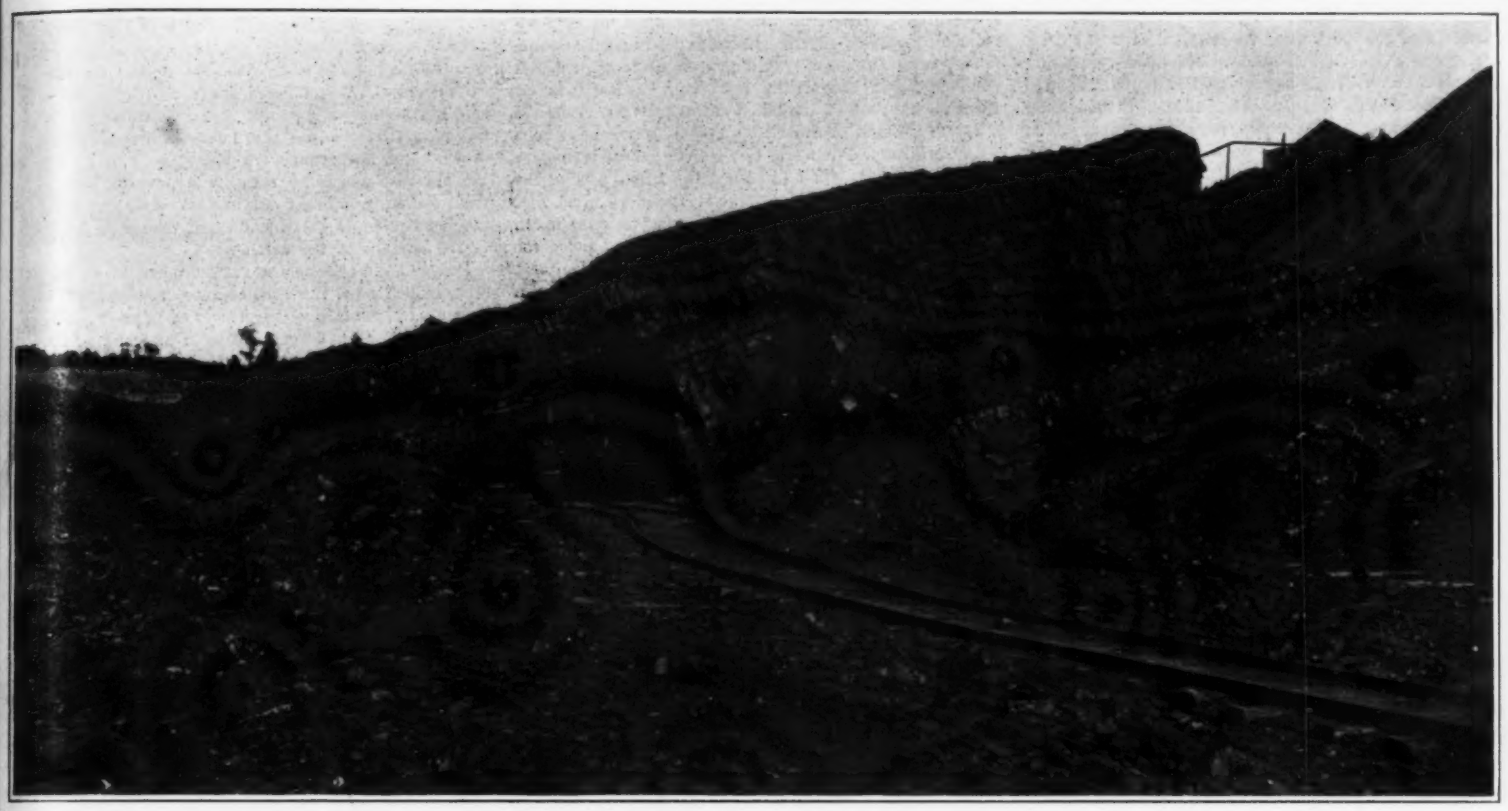

"Round house" for "lokeys" excavated out of a coal mass.

Drifting stripping with "barrier pillar" in the background and "round house" at the center.

OPEN AIR COAL MINING.—[See page 148.]

Volcanic Action and Newly Recognized Types of Volcanoes*

By Prof. E. H. L. Schwarz, F. G. S.

I PROPOSE in this article to review very briefly recent work, confining myself to actual observations in the field or the laboratory, and picking out only those points which are fundamentally new.

I will begin with the West Indian eruptions, more especially dealing with the Mont Pelée. Mont Pelée, which but once, in 1851, had been known to show signs of activity and then only by throwing out a harmless shower of ashes, commenced its eruption on April 25th, 1902. Excursionists immediately ascended the mountain and found that the bowl-shaped hollow at its summit, called L'Etang Sec, was being filled up with boiling mud from which sulphurous vapors were being given off. Eight days later, ashes were ejected, and on May 5th an avalanche of incandescent mud rushed down the valley of the Riviere Blanche and overwhelmed the sugar factory of M. Guerin, burying the owner and his wife and twenty-five employees. On May 8th, at ten minutes to eight in the morning, a blast, blown as if from a funnel, and directed immediately onto the town of Saint Pierre, scorched and killed every living being, with the exception of two men, within the city, to the number of twenty-six thousand. The area of total destruction was quite narrow, but all the country to the west and south was scorched, though many people escaped who were within this outer zone. Other eruptions occurred on May 26th, June 9th, July 9th and 11th. On August 30th, after a period of quiet during which the residents around the mountain were beginning to become reassured and the fugitives to return, a second blast, as sudden and fierce as the first, was blown out, directed this time to the south and east, which destroyed a new area of country. Heilprin had actually visited the crater on the previous day and was on the margin of the cloud when the blast occurred. It is the nature of this blast which is of the utmost interest; the shower of ashes which preceded it and the torrential rain due to the violent disturbance of the atmosphere, which washed down this ash and covered everything with a slimy coating of grey ash, are phenomena well known from other volcanoes in their explosive stage.

Pliny, Epistola XX., describes a similar blast in the eruption of Vesuvius in 79 A. D., an eruption of a volcano likewise starting activity after a lengthy period of quiescence: "*Ab altero latere nubes atra et horrenda igni spiritus tortis vibratisque discursibus rupta in longas flammarum figuras dehiscebat; fulguribus illæ et similes et majores erant,*" which we may translate, with the accounts of the eye-witnesses of the Mont Pelée eruption to guide us: "From the other side a black and terrible cloud—the spirit of fire—belched forth with whirling and quivering offshoots, and rent with long trails of flame like flashes of lightning, only broader." Earl Orrery in his translation renders *spiritus igni* as "charged with combustible matter," but the sense seems to be more the "essence" or "soul of fire;" the descriptions of those who breathed this "spirit of fire" and the condition of the bodies both at Pompeii and Saint Pierre seems to point to something more than combustible matter or even heat.

Two people escaped from the area of all but total destruction. Of these, Leon Compere-Leandre, a shoemaker, was sitting on his doorstep at the time of the blast; he rushed indoors and sheltered himself under the table. Four others came running into the room, one of whom, a child of ten years, dropped dead and the others fled. He himself came out from under the table and went into another room, where he found an old man who had fallen dead on his bed; the corpse was blue and swollen, but the clothes were intact. After finding the rest of the people in the house were dead, he threw himself on his bed and lost consciousness. At the end of an hour he woke up to find the roof burning; then, covered with burns, he fled and reached Fond-Saint-Denis, three miles distant, where he was attended to. He said that he had not felt a sensation of suffocation nor was there a want of air, only that the air was burning.

The other man who escaped was Auguste Ciparis, a negro, who was shut up in a cell in the prison without a window and only a narrow grating in the door. He was waiting for his usual breakfast on the 8th when it suddenly became dark; immediately afterward hot air entered his cell through the grating. It came gently but fiercely. There was no smoke nor noise nor odor to suggest burning gas, but it burnt his flesh; he was clad in his hat, shirt, and trousers, but these did not take fire, yet beneath his shirt his back was terribly burned. The water in his jug was not affected and this was all the nourishment he had till he was rescued three days later by a party searching for the living.

Most of the victims seemed to have succumbed instantaneously, as if from a blast of choke-damp. Some were burned internally, having as the coal miners say, "swallowed fire;" in some instances their heads burst; others were scorched all over. A doctor's carriage stood ready before the house with the charred body of the horse in its place before the carriage; the metal parts remaining showed that it had not moved and the coachman was by its side. Clothing was never burned, but the victims in the streets had their clothes torn off them by the rush of the blast, as happens sometimes in a severe tornado in America. People in the outer zone who were rescued fell into two classes: those who were burned internally—that is to say, the upper part of the respiratory canal was destroyed; these all died. Of the others, some were singed all over, while some again were burned on the face and on their hands, and these mostly recovered quickly.

The evidence seems to point to the blast having been made up of an intensely hot heavy gas. Sulphurous vapors were given out before the blast but did not accompany it. M. Molinar, who observed the whole occurrence from Mont Parnasse, relates that the volcano vomited fire during a quarter of an hour and then became completely quiet; at eleven o'clock, lava and smoke began to pour out. Had the blast been water-vapor, there should have been some clouds due to the condensing vapor, but though the wind was blowing away from where M. Molinar stood and the view was perfectly clear, no clouds were seen to form. The statements at any rate establish the fact that a volcano can discharge a mass of gas downwards and that this gas is like that of a mine explosion. It desiccates, as witness the trees in the outer zone which were rendered sapless, but the leaves still hung from the brittle twigs; and it is certainly not water-vapor. What this gas is can only be guessed from Brun's researches.

Dr. Brun commenced his work in 1901 and finished his field observations in 1910. During this time he had visited the Italian volcanoes, those of the Canary Islands, Java and the Hawaiian Islands. His laboratory work consisted in determining the melting-points of rocks and rock-forming minerals, especially those of volcanic origin, and the analysis of gases collected from actual volcanoes either in the explosive stage or driven out of lavas in which they had become dissolved or occluded during cooling. Brun's method in the field may be gathered from his account of the ascent of Mount Semeroe in Java. Having watched the crater in eruption from a distance for some time, Brun desired to look down into the working chimney. Profiting, then, by an interval between two explosions he rapidly approached and stood on the actual rim of the crater. He was able to snap three photographs one after the other. Hardly had he finished when an explosion burst out—still he could photograph, though incandescent blocks fell all around. He observes that investigations made overlooking the volcanic orifices during the paroxysmal stage are very rare and to profit by them one must have complete control over oneself and know beforehand on what he must concentrate his attention. When he arrived at the rim of the crater the western chimney of the three that were filled with liquid lava was belching forth gas and bluish smoke; little masses of lava were being gently lifted and from the resulting crack gas was being vigorously expelled, rising with a violent whirling motion like that of a water-spout. The gas and fumes were insoluble in air. At the moment of the explosion not much could be seen, but from the number and velocity of the ejected blocks it was evident that the nearest chimney had entirely emptied itself. The rim on which he stood was swept with fumes, but there was no condensation on the cool surface of the rocks. On another occasion Brun thrust his geological hammer into the uprushing stream of gas and no water was condensed on the bright metallic surface.

In a neighboring vocano, Bromo, the continued explosions prevented Brun from looking down into the crater. So he caused a little platform to be cut in the loose cinders just under the rim on the outside; on this he established his battery of thermometers, barometers and hygrometers, and also a little pump which had attached to it a long train of glass tubes connected by India-rubber joints, which was dangled into the crater. When an explosion took place the hygrometer showed no excess of moisture in the air. I can, however, find no account of an analysis of the gas thus collected directly from the throat of the volcano by the pump. Elsewhere Brun relies on the gases occluded in the lava; these are expelled on heating the rock to a certain temperature above the melting-point. Plutonic rocks and lavas which have been in existence for long geological periods are "dead," and do not contain, or have lost, occluded gases. Recent lavas when heated to their explosion-point suddenly give off with tremendous violence large quantities of chlorides—magnesium, iron, and silicon—together with ammonium chloride, carbon dioxide, carbon monoxide, marsh gas, chlorine, hydrogen chloride, and less frequently sulphur dioxide and sulphuretted hydrogen, and lastly, hydrogen and nitrogen, but neither oxygen nor water. Gautier points out, however, that the gas of fumaroles are generally hydrous. But then fumaroles belong to a late stage of the volcano, when the activity is dormant and water from the surrounding rocks can percolate and attain to the hot centre of the volcano and thence be driven up to the surface of the earth.

Fouqué's analyses of the gases from Santorin in 1866, although collected from the surface of sulphurous water in a fissure, contained only traces of oxygen but nearly 30 per cent. of hydrogen, nitrogen and carbon dioxide practically making up the rest. Specimens of the gas taken in later stages show a progressive increase in oxygen and in carbon dioxide. The fact that chlorides of magnesium and iron are deposited on cinders around the crater again proves, according to Brun, that the exhalations of volcanoes are anhydrous. The "steam" of volcanoes consists of volatile chlorides, mostly ammonium chloride. If the "steam" had been water-vapor, it would dissolve in air and soon disappear. The white cloud, on the contrary, remains suspended during long periods over the volcano and the wind may carry it many miles to leeward. The most positive evidence Brun advances is his measurement of the humidity of the cloud given off from the pit of Kilauea in eruption relatively to the humidity of the air outside. In a long series of observations, he found that there was less moisture in the cloud than outside it, and consequently he inferred that there was no water-vapor in the exhalation. On the other hand, the cloud of the fumaroles on the north of the pit, in action at the same time as the volcano, contained much water-vapor. Gautier found from 62 to 77 per cent. of water-vapor in the fumaroles of Vesuvius after the eruption of 1906; but in view of Brun's work in Hawaii, one is not justified in maintaining that the gases of the central chimney must equally be hydrous. Moissan's analyses of the gases of the Mont Pelée fumaroles, interesting from the fact that considerable quantities of argon were discovered in them, show large amounts of oxygen and water-vapor. It will be remembered, also, that in the beginning water was pumped up into L'Etang Sec and caused the mud-rush which overwhelmed the Usine Guerin. That is to say, when a volcano begins to work after a period of quiescence, the volcanic gases drive before them the water contained in the crevices and pores of the rocks; then, when the eruption ceases, the same water from the surface seeks to penetrate again into the cracks which it previously occupied. As the pressure of the volcanic vapors grows less and less, the surface water advances more and more into the heated area, till, coming at last into the neighborhood of the cooling molten rock, it is driven forth in the form of aqueous vapor mixed more or less with volcanic products.

The elements of water, it is true, are found in the volcanic exhalations, but combined with carbon, chlorine, or nitrogen. The combined nitrogen appears to be the result of the action of hydrogen on metallic nitrides. Silvestri actually found nitride of iron on the surface of lava from Etna. Metallic nitrides, when heated with hydrogen or water-vapor, yield ammonia, and this would readily form sal-ammoniac with the hydrogen chloride of the exhalations.

So far for the gases given off from volcanoes; the types of volcanoes that yield them are those that have been known since the earliest times. In Iceland and in the Snake River Plains of Idaho, there are types that are entirely new to scientific literature. The commonly known types are mostly those connected with the folding in the earth's crust. In the Mediterranean and West Indies the volcanoes lie uniformly at the back of the great folds; in the Ægean and in Mount Ararat, the volcanoes lie in a "Schaarung" or knot where two systems of folds meet. In Kasbeck and Elbruz the cones lie in the centre axes of the folds, while in the Andes they are related at any rate to the folds in that they follow lines of weakness determined for them by the curvature of the strata. In Iceland and in Idaho, the whole country for thousands of square miles has been a seething mass of lava and the vents rise through it

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as if drilled by gases that have come through a semi-viscid magma without any sort of order. The special types represented here are the explosion rings, the slag craters, and the buckler cones; then there are the fissure eruptions which are well known and the volcanoes of block-uplift which are new to science.

Explosion Rings.—These are the more primitive forms of what Judd calls crater rings, of which many examples occur in Italy, such as the hollows in which lie the lakes of Bolseno, Bracciano, Albano, Nemi, and Frascati. The simplest of all occur in Idaho near Cleft, where there are two circular holes drilled through the basalt without any elevated rings. Their diameters are 1,100 and 800 feet; the encircling cliffs rise 200 feet above the floor, which is composed of fine yellow soil. In Iceland we find a slight development; the type is the Hrossaborg, near Akureyri, the capital of North Iceland. Here the plains consist of doleritic lava overlying pelagonite tuff, and the volcanic eruption has lifted up a portion in the form of a circular hill with a crater, some 800 yards in diameter, on top. The only products of the volcano were gases which have drilled the circular chimney and elevated the rocks around. The inner walls of the crater are 120 feet high, and on all sides the rocks slope outwards. It is a typical crater of elevation according to Leopold von Buch, only unfortunately we cannot apply this term to this type now, as the original name was used erroneously for the ordinary strato-volcanoes which are built up of successive layers of ash and lava-flows from the actual chimney that they surround; in the Hrossaborg the lava and ashes are older, and came from other volcanic vents or fissures.

From these explosion rings, or Gasmaare, as Beck calls them, we pass to the well-known crater rings surrounded with low crater walls formed of tuff and lava ejected from the volcano. Many examples occur in Iceland and Idaho, but no special mention of these is necessary here, unless to point out that in Idaho vast streams of lava issued from them. These heads of the lava columns are covered with scoriaceous and ropy lava, which makes them look like the tops of great springs of water, suddenly congealed. In one case, a particular lava-flow had its origin in two such pools, and a mile from its source it was joined by a still larger river of lava. The united streams flowed some thirty miles, descending about a thousand feet, more than half of the fall being in the first ten miles, so that the distal portions flowed on a gradient of 1 in 200. Other streams have flowed for fifty miles in the same area in rivers of molten rock one to three miles across and 300 feet in thickness.

Slag Craters.—Two volcanoes of this type are described by Russell from Idaho. Blanche Crater rises about 60 feet above the plains, and has a perfect crater on top; the conical pile is composed of thin cakes of highly vesicular lava, which have been blown out in a plastic or liquid condition. It is of quite recent origin, as it lies in a canyon excavated 500 feet in the older lava. The other example is the Martin Butte, likewise a conical pile of scoriaceous lava. In Iceland, slag cones are extremely common and form the most weird objects in the landscape, as the viscid lava has built up piles of all shapes, resembling towers, organ-pipes, needles, or gigantic skittles. They vary from 150 feet in height to quite small hornitos or blowing and driblet cones. They are often assembled in swarms, as if a great mass of gas had pierced a viscid covering along a number of independent channels. They frequently form, also, the caps of the next type of volcano.

Buckler Cones.—One example has been described from Idaho, the Black Butte; it rises 300 feet, with a base two miles in diameter. It is built up of successive layers of highly scoriaceous lava, which flowed away in all directions, and there is no evidence at all of lapilli or cinders. There is no crater on top, the last lava-flow having filed it up. In Iceland this form is very common, some nineteen "Dyngjen" being known, but owing to the low angle of the cone, the slope varying from 6 degrees to 8 degrees, they are easily overlooked, especially in the snow-covered area. One such buckler cone, the Skjaldbreid, is 3,000 feet high, and seven miles in diameter at the base; it has a small crater on top, but others may have very large ones. In the Kalotta Dyngja, a post-volcanic fissure has cut through the cone, and it is therefore possible to study its internal structure. Mauna Toa, in Hawaii, belongs to this type, although the great spreading base is concealed beneath the ocean.

Fissure Eruptions.—Iceland has long been known as the typical locality of this type of volcano. The eruption of Laki, or Skapta Jokûll, occurred in 1783. The first eruption took place on June 8, and was accompanied by tremendous detonations and earthquake shocks. A great black bank of ash was thrown into the air, in which several up-rushing columns could be seen; that is to say, the explosions occurred at several places along the fissure. Later on, the explosive stage became confined to the southern half, while the northern half poured out lava, as was evident from the reflection of the glowing mass in the overhanging canopy of cloud. On June 12th a lava stream, 200 yards wide, had flowed nine miles down the bed of the Skapta River. The lava in this part is covered with hornitos, little blowing cones, whose origin is ascribed to the escape of water-vapor which the lava had absorbed from the river water. Towards the end of June the eruptions ceased for a time, but in the beginning of August activity was renewed, and stream after stream of lava flowed down the river-beds, destroying all the meadow land adjoining. After a period of rest, the eruptions started again on October 25th, when the entire plain in the neighborhood became a glowing lake of lava, and the molten rock continued to flow during the whole of November. All this time the air was filled with ash and sulphurous vapors, and the vegetation over a large part of the island was killed; half the animals perished, and 5,000 people, out of a total population of 50,000, died of famine or disease. Iceland is full of such fissures, as also in all probability was the whole basaltic plateau of which it is part. The effect of fissure and other eruptions occurring more or less simultaneously over an area little short of a million square miles, must have had a far-reaching influence on the climate of the world; one can almost assert that it was this which was the cause that enabled a tropical flora to flourish in the Eocene period close to the North Pole, and that the epidemics consequent on the pollution of the air were a factor at any rate in the extermiantion of the Mesozoic types of animals. Not only in North Europe and America were these volcanic outbursts active, but in India the Deccan traps were extruded at about the same time, and also probably the lavas of the Mawi plateau in Central Africa. Contemporaneously with these eruptions the crumpling of the earth's crust, which gave rise to the Alps-Himalayan chains and the folds of the east of the Pacific, was also started; the vast dislocations of the earth's crust and the floods of lava which issue from it in certain parts, bring up the question whether this solid earth can contain within itself such terrific forces of disruption; or whether it is not more reasonable, seeing that we have recently had visitors from celestial space such as the planetoids Eros and M. T., which, had they fallen upon the earth, would have caused just such disturbances, to ascribe the early Cainozoic eruptions and crumplings to causes operating entirely from without the terrestrial sphere.

Volcanoes of Block-Uplift.—Reck calls these Tafelberghorste, but in Iceland they always have a volcano on top. The question whether they are horsts, that is blocks from which the neighboring country has been faulted away, or whether they owe their origin to vertical uplift, is a matter very difficult to decide. In the Utah and Colorado plateaux, the whole country is parcelled out in long strips and the difficulty of explaining the occurrence here is as great one way as the other. If the valleys between the long plateaux had been faulted down, how could the strips between have been sustained, with the earth's crust all shattered around them? It is like the case of a pancake laid on a gridiron, but then the rods of the gridiron are here represented by narrow slips of rock fifty or more miles long, and these are not strong enough to allow of suspension from the ends. Masses of igneous rock pumped up by hydraulic pressure would supply an elevatory force for the plateaux, and this seems a more reasonable explanation; hence these Colorado and Utah plateaus are still called mountains of block-uplift. In the Ries in Germany, again, there is a circular depression some fifteen miles in diameter; it is surrounded by Jurassic strata resting on granite, while in the depression, whose floor is the same granite, the level of this rock is above that in the surrounding country, where it is covered with sedimentary beds. The Ries granite, then, is a gigantic plunger which has been elevated by volcanic forces, and the balance of evidence seems to indicate that the fault-blocks of Iceland have been elevated in a similar manner, although they are bounded by quadrilateral and not circular faults.

The simplest example of a volcano of block-uplift is the Herdubreid in the lava desert of the Odadahraun. The cliffs surrounding the block are some 1,800 feet high, 300 feet of which are concealed under tabus heaps. The rock comprising them is brown pelagonite tuff, covered on top with the basalt, which flowed from the central chimney. The volcano is of the buckler type, with a deep central crater, from which lava poured out in a symmetrical low angle cone. It is 5,450 feet high and rises some 4,000 feet above the plain. The walls of the pedestal on which the lava rests are kept quite fresh by the enormous weathering that goes on in such regions; there is no sign of any fissure traversing them by which the volcanic gases could have arisen to form the chimney. The block has been driven upwards between two sets of crossing faults and an escape vent has been driled in the centre through the solid rock.

To the southwest of the Herdubreid lies the much larger Dyngjufjöll block, with the square caldera of Askja at its summit. The lava desert, with its surface so scoriaceous and rent with chasms that it is all but impossible to traverse, is here covered with pumice thrown out by the Rudloff crater which lies in the Askja. A narrow gorge, the Askja Op, leads up to the top at the northeastern corner. On entering the Askja, one finds oneself in a wide, level plain filled with slaggy lava and surrounded on all sides by steep hills, whose crests turn round at right angles and enclose the square caldera. The area of the depressed lava-field is about sixteen square miles. The surrounding hills rise from it 1,000 to 1,200 feet, but from the outside they rise from 2,000 to 2,500 feet. The outer dimensions of the block are, roughly, fifteen miles on all four sides. The remarkable fact about the Askja is that the boundary hills are made of the older pelagonite tuff of the same nature as that forming the pedestal on which the Herdubreid volcano stands. In the Askja the volcano was formed in the same way, but towards the end of its activity the mass of lava collapsed, leaving a rim of the pelagonite tuff standing all round.

Synthetic Tannin

CONSUL BENJAMIN F. CHASE, Leeds, England, advises that what is said to be a successful synthetic tannin has been discovered by Dr. Edmund Stiasny, assistant professor of the leather industries laboratories of the University of Leeds. The new tannin, which is cilled Neradol, is made from tar distillation products, the synthesis being carried out by sulfonating cresylic acid and combining it then with formaldehyde. The white color of the Neradol-tanned leather and the brightening and bleaching effect of Neradol when used in combination with other tannins (vegetable and chrome) are especially noteworthy. The *Leather Trades Review* states:

Neradol is somewhat similar to ordinary tanning extract, and forms a light brown solution in cold water. It is a pure tannin of 30 per cent strength according to the hide powder method, and can be used in smaller quantities to obtain the same effects as those at present produced by the ordinary agents.

Dr. Stiasny has made a series of tests on hides and sheep and calf skins and has recently showed samples of leather ranging from light glazed kid to sole leather produced either with synthetic tannin alone, or with it in combination with vegetable tannin, chrome, or wood-pulp liquors. In every case the product appeared to be satisfactory, the leather being supple, fine, and strong in the case of the light skins, while the sample of insoling belly was flexible and clear and light in color. However, the synthetic product is not likely to interest greatly the sole-leather manufacturer while it is the custom to sell such leather by weight, as the new tannin does not give weight; in fact, it produces a light tannage, and is, therefore, more likely to find commercial application in the manufacture of light leathers. But it is said to be useful in the early stages of sole-leather tanning to prevent drawn grain.

FUTURE USES OF THE NEW TANNIN.

It is quite possible, especially when it can be produced more cheaply—the price is stated to be about $97 per long ton—that the adoption of Neradol tannage may have to be seriously considered by those interested in chrome tanning. Meanwhile it is probable that this synthetic material may be used in conjunction with both vegetable and chrome tannages, as it is claimed that it considerably hastens the process, and that, contrary to the general effect of quick processes, it improves the quality of the leather at the same time. It is stated that it has been already used on a fairly large scale in the German tanning industry. An advantage of the new tannin is that it can be prepared in a uniform manner, and the material is not subject to chemical changes.

An interesting experiment recently carried out consisted in placing a piece of calf pelt, which was badly discolored, in a solution of the synthetic tannin. After a few minutes the discoloration had completely disappeared, and the pelt was almost white. In about two hours the pelt was struck through with the tannin. The time occupied in tanning the various samples shown by Dr. Stiasny varied from two days to a few weeks. The combination tannage of Neradol, wood pulp, and vegetable tannin on a stout sheepskin took four days. Thus it seems that the new product will prove of great benefit to the tanning industry.—*Journal of Industrial and Engineering Chemistry.*

Hoisting plane leading out of the Drifton stripping.

Small locomotive or "lokey" and steam shovel at work.

Big enough to look like the Panama Canal.

Open Air Coal Mining

Stripping Methods Employed in the Anthracite Coal Region of Pennsylvania

By E. J. D. Coxe

THE Anthracite Coal Region of Pennsylvania, owing to the geological conditions that brought about its formation, presents many problems to the mining engineer that do not exist in any other producing coal region of the world. The tremendous contortion of the strata which has changed the flat-lying bituminous coal beds into anthracite or "natural coke," by means of heat and enormous pressure, is the principal cause for the engineering difficulties encountered. The great variation in thickness of the different coal beds or "veins" also raises problems that the bituminous mines in this country do not encounter.

Since comparatively early times in the history of anthracite coal mining, "stripping," or the removal of the top cover of shallow-lying coal beds, has been used as a method of mining in the anthracite region; but with the development of the steam-shovel, which so greatly reduced the cost of excavation, stripping has in recent years become a more and more important method of mining. The economy of stripping over underground mining is twofold. In the first place, after the cover has been removed all coal in the bed becomes available, and 100 per cent goes to market instead of having to leave from 15 to 40 per cent in the ground, as is necessary in underground mining. In the second place, the coal can be mined by a steam-shovel at a small fraction of the labor cost of underground work. The expense of stripping of course lies in the very great first cost of removal of the top cover. The question "Whether it will pay" to strip a given tract is often a very delicate one for the engineer to decide, but the improvement in excavation methods in recent years has greatly increased the amount of cover that can be removed for a given quantity of coal. In some cases 4 feet of rock are removed to uncover 1 foot of coal, or in other words, 160 feet of rock is excavated to uncover a 40-foot coal bed. An elaborate exploration of the rock and coal strata involved, with the aid of the diamond drill, is the only method by which the engineer may obtain proper data before deciding for or against the stripping method of development.

Strippings are of two general types, those which uncover only a portion of the coal bed where it approaches the surface, or "out-crops," and those in which the entire coal bed, or "basin," is stripped. In the former case the coal is usually removed through the underground workings of the same vein, which are too deep to strip. Strippings of the second class are much larger operations. Several at present in operation in the Lehigh or Middle Anthracite field are big enough to look like sections of the Panama Canal.

The largest stripping in existence is at the Drifton colliery of Coxe Bros. & Co., Inc. Fig. 1 shows a sketch map of the work at present, and Fig. 2 shows a north and south cross section of the formation through the western end of the stripping. As in all other coal basins of the Middle or Lehigh district the coal beds here lie in long narrow "canoe-shaped" basins of varying width and depth, the long axis of the basin running in a north-of-east to south-of-west direction. The most important coal beds in this basin, taken in their order from top to bottom, are the "Mammoth" bed, from 35 to 40 feet thick; the "Wharton" bed, 6 to 7 feet thick; the "Gamma," which is rather irregular and in some places unworkable, but averages about 3 feet in thickness; and the "Buck Mountain" bed, from 12 to 16 feet thick. The last named, on account of its being very much deeper than the others, covers a much greater acreage between its out-crops, but of course for the same reason is not suitable for stripping operations except at certain points near the out-crop. On the western portion of the Drifton basin the Mammoth and Wharton beds are only separated by a thin stratum of rock from 2 to 3 feet thick, as will be seen by reference to the cross section, and sufficiently approach the surface so that stripping operations are possible. The stripping is located on the extreme western end of the Drifton tract of the Tench Coxe estate, the coal basin extending to the west under the land of the Lattimer colliery of Pardee & Co., who also strip the Mammoth seam on their property. One of the photographs shows a view of the western end of the Drifton stripping, taken from the top of the hoisting plane, with the "barrier pillar" between the Drifton and Lattimer tracts shown at the left background. The dark mass in the center of the picture is a mass of coal that has been left standing for the present, as the tunnel under it forms a convenient "round house" for the small locomotives or "lokeys," that tend the steam-shovels.

The earth and rock excavation of strippings is usually let out under contract to stripping contractors. After the cover has been removed the coal companies handle the excavation or mining of the coal themselves. Several of the rock-shovels now in operation are capable of handling five tons of rock at a load. At the Drifton stripping the Mammoth seam averages about 35 feet in thickness, with the Wharton seam 6 feet below it, and with only 2 feet of rock between. Thus the stripping lays bare about 41 feet of available coal. As will be seen from the map, the operation is over 800 feet broad at its widest point and 2,000 feet long. The greatest depth to the coal

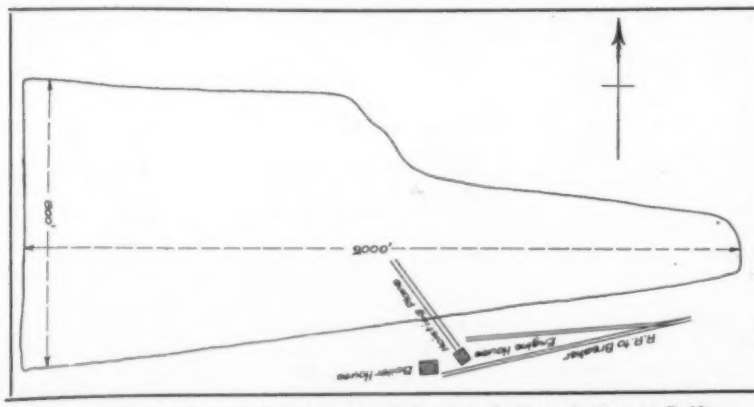

Fig. 1.—Sketch map showing the general lay-out of the stripping at Drifton Colliery.

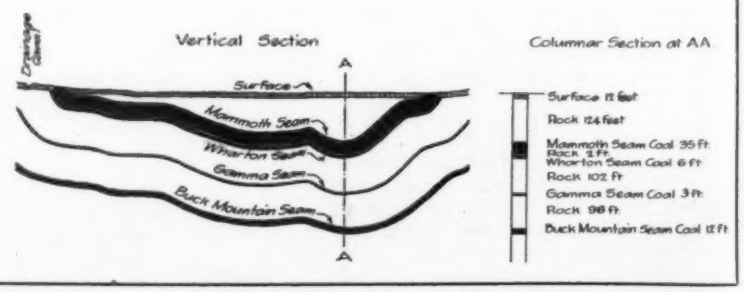

Fig. 2.—North and south cross section of coal bed formation through western end of stripping.

is about 140 feet and the excavation will be 180 feet deep after the coal is removed. The detrital surface material is about 12 feet thick and the rest of the cover is rock. The total excavation of cover (surface and rock) to date is a little over 3,000,000 cubic yards, which has laid bare about 1,700,000 tons of coal.

The "Gamma" and "Buck Mountain" beds of coal are mined by underground methods, under the area covered by this stripping, as their depth is too great to make stripping them practicable.

The method of mining the coal in the strippings consists of blasting the coal in large sections by gangs of men working ahead of the steam-shovel, which then loads it into mine cars brought to the shovel by little "mine-lokeys." The shovel is able to load about 500 mine cars of three and one half tons capacity each in a working day. After the trip of cars is loaded the lokey hauls them to the foot of the hoisting plane, where they are hoisted two at a time to the surface. They are then hauled by larger locomotives in trips of about twenty cars each to the breaker, about three and a half miles away. This "breaker" handles all the coal from the Drifton colliery, which includes four underground mines besides the stripping.

The method of blasting coal in advance of the steam-shovel is of interest. A series of holes is drilled, usually by steam drills, from the surface of the exposed coal through to bed rock. At the bottom of each hole a charge of dynamite, called a "leader-blast," is exploded. This does not break up the coal strata, but shatters a small pocket of coal at the bottom of each hole. Each hole is then filled with water and a small charge of dynamite is sunk through the resulting mass of fine coal and water to the bottom of the hole. This charge is then exploded, which "cleans" the hole, throwing out all the coal dirt with the water. The enlarged cavities at the bottom of each hole (and against the bed rocks) are then filled with black powder. Several of these holes are then fired simultaneously, the result being that the entire area of coal is "loosened up" ready for the steam-shovel. In a single blast made recently at the Drifton stripping eleven holes were bared and twenty-five sticks of 40 per cent dynamite exploded in each hole as a "leader blast." In the resulting cavities from ten to fifteen kegs of black powder were placed in each hole, and the eleven holes fired together. The resulting explosion "brought down" six thousand mine-carloads of coal, or approximately 21,000 tons.

One great advantage of this method of blasting is that while breaking up the coal sufficiently for convenient handling by the steam-shovel, it reduces to a minimum the percentage of fine sizes. There is very little "dirt" produced and a very large proportion of the coal goes to the breaker in large lumps.

Bird Calling*

An Attractive Art for Lovers of Nature

By W. A. Nicholson

THE art of attracting wild birds is one little known or understood except by those whose special interest lies in this direction. The bird-catchers, and those who trade in live birds, understand little, if anything, about this subject, and even the bird-catchers themselves seldom practise it, relying almost solely upon the live decoys shut up in small cages wherewith to attract their wild companions to the deadly limed twigs. One must be well versed and possess a thorough knowledge of the notes emitted by birds, besides being acquainted with their habits, before he can employ the aid of calls with success, and the professional bird-catcher is an individual of too indolent a character for this work, which, doubtless, is the principal reason he leaves it severely alone. Those who use bird-calls regularly are the bird-photographer, the field naturalist and the wild-fowler, and all with the one object and main purpose of decoying the species and making them come nearer, the first, to enable him to secure a good negative and larger picture; the second, to extend his knowledge of the habits of a species; and the third, to secure the specimen. The wild-fowler, however, makes use of few calls, often not more than six, these usually being those imitating the cry of the wild duck (mallard—see Fig. 5), curlew (see Fig. 2), golden plover (see Fig. 1), green plover (see Fig. 3), wigeon and teal (see Figs. 18, 15 and 9), and often two only are regularly carried, these being the calls of the golden plover and curlew. As will be observed from the illustrations which have been reproduced from photographs of various patterns in my possession, that I make use of regularly, there is quite a collection of different kinds, a total of eighteen being here represented. It is at all times advisable to procure the very best that are made, for the simple reason that with care they give the finest results and will last for many years. As remarked above, the successful use of these calls chiefly depends upon the operator and his practical knowledge of the proper notes emitted by the birds in a wild state, and without experience of the latter it will be only time wasted to endeavor to manipulate them, except, perhaps, with the exception of two of the instruments, namely, that of the wood-pigeon (see Fig. 17) and the golden plover (see Fig. 1). These two are the simplest to operate and little practice is necessary to enable one to make successful use of them. The wood pigeon call may also be substituted for that of the cuckoo, and a little practice with it soon enables one to acquire the correct pitch and modulation of sound necessary. It is very interesting to visit a breeding haunt of the wood pigeon with one of these calls. My method is to conceal myself (I use a hiding tent for this purpose, which is furnished with tapes, to which I attach twigs, grass, and so on, and make use of the surrounding undergrowth to screen it) under the nesting trees, having previously arranged my camera in position, and send out a few notes. As generally happens, the cushats in the immediate neighborhood are cooing all around, and, at first, little or no notice is taken by the birds of one's efforts, but the secret is to continue to call, not, however, uninterruptedly, but with pauses of about four minutes, making a fairly high pitch in the tone, when the birds will be observed to crane their necks downward and stop cooing. Some bolder than others fly closer to the hidden caller, often approaching to within a few yards, and altogether the call, always assuming the proper sounds are given, has a most alluring effect on wood pigeons during the commencement of one of their breeding periods. During incubation, however, the birds pay little heed to artificial calls, and at such times it is useless trying to attract them. Another easily duped species is the cuckoo, which may be enticed to within a few feet of the manipulator, and the same may be mentioned of the golden plover (see Fig. 1), partridge (see Fig. 8), pheasant (see Fig. 16), and little grebe (dabchick). Species somewhat more difficult to deal with are the wild duck (mallard — see Fig. 5), curlew (see Fig. 2), snipe (see Fig. 10), owl (see Fig. 4), wigeon (see Fig. 18), magpie (see Fig. 12), oyster-catcher, and red-throated diver. All the calls illustrated should be worked with the left hand, so as to leave the right hand free for manipulating the shutter of the camera and other necessary items.

The art of bird-calling here briefly illustrated is a most interesting study, possessing a peculiar charm, a charm impossible to describe, and one having a fondness for ornithological pursuits, and with plenty of time to spare, could hardly do better than take up so absorbing a hobby, the acquisition of which would repay him a thousandfold. But such a one must be possessed of great patience and perseverance, otherwise failure is certain.

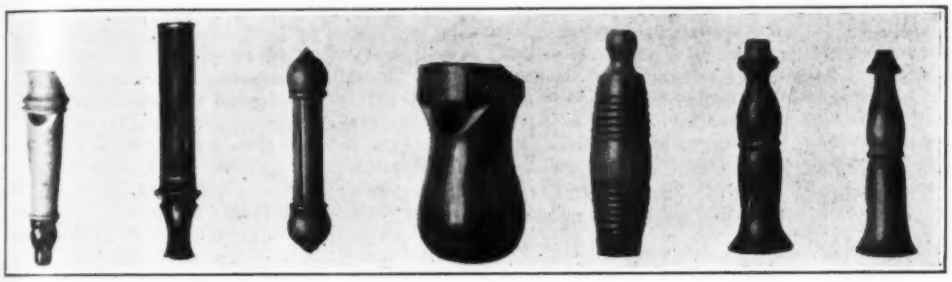

Fig. 1.—Golden Plover. Fig. 2.—Curlew. Fig. 3.—Green Plover. Fig. 4.—Owl. Fig. 5.—Wild Duck. Fig. 6.—Hare. Fig. 7.—Hare.

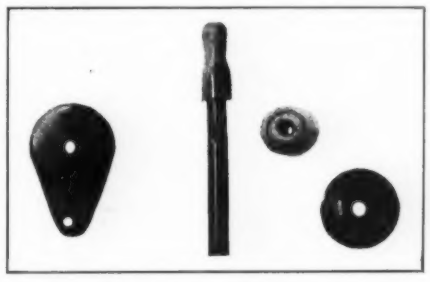

Fig. 8.—Patridge. Fig. 9.—Teal. Fig. 10.—Snipe. Fig. 11.—Blackbird.

*Reproduced from *Knowledge*.

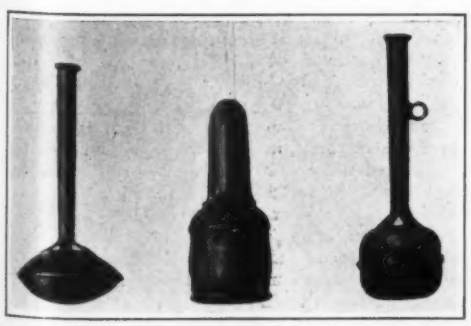

Fig. 12.—Magpie. Fig. 13.—Rabbit. Fig. 14.—Jay.

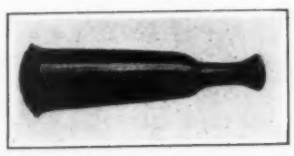

Fig. 15.—Wigeon (improved pattern.)

Correction

In an article entitled "Cellar Space Made Available by the Use of Prismatic Glass." (Supplement Aug. 16, 1913, p. 107.) certain dimensions were mistated owing to an unfortunate printer's error. In the fifth paragraph of the second column the dimensions of the areaway should be 4x4 feet and in the 10th paragraph 2 inches from the ceiling, and 2 to 2½ inches from the floor should be the same number of feet in each case.

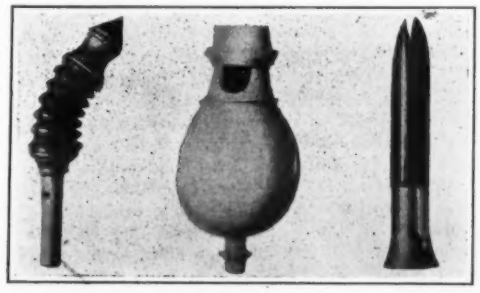

Fig. 16.—Pheasant. Fig. 17.—Woodpigeon. Fig. 18.—Wigeon.

Some Aspects of the Subject of Transportation

II.—Inland Waterways

By Lieut-Col. J. Kuhn

Continued from SCIENTIFIC AMERICAN SUPPLEMENT, No. 1965, Page 189, August 30, 1913

On a good macadam road a team of horses can move 4 tons; on a track laid with steel rails the same team can haul 10 tons; hitched to a canal boat it can haul 200 tons. In other words, at low speeds, the tractive resistances of water-borne loads are approximately one twentieth of those on a steel laid track. With such an advantage in its favor, it may well be asked: Why has not water transportation held the field against all other forms? Notwithstanding that, in certain European countries, canals and rivers are still important as transportation routes, and it is a fact that in the United States inland navigation, with a few notable exceptions, it is not only languishing, but has almost suffered extinction. In spite of generous and persistent appropriations by a paternal government for the improvement of rivers and the construction of canals, navigation has failed to respond, and the yearly returns indicate a declining tonnage. Of the numerous State canals built between 1820 and 1840, all have succumbed save the Erie, and its traffic has not kept pace with the growth of the country. It has not infrequently been charged that the decline of our inland water transportation was brought about by the deliberate machinations of the railroads. While we may safely assume that there is no love lost between rivals in business, it is inevitable that in the final analysis the survival of the fittest will be determined by economical considerations alone. The triumph of the railroad in competition with the early canal is due solely to the fact that the former proved itself a better all around agent of transportation. There are a number of reasons to account for this, among which the following are the more important.

1. The greater adaptability and flexibility of the railroad to meet the wants of transportation, and its relative independence to topographical consideration as compared with water routes, which must follow more or less available natural water supplies. This enables railroads to be located so as to go after existing or potential traffic where a water route would be economically impracticable.

2. Railroads can bring their transportation facilities to the very doors of industries by running switches into factories and warehouses, thus eliminating cartage charges. To secure the same advantages with a water route the industries would have to be located upon the edge of the channel, where foundations are sometimes troublesome and where flood damages are liable.

3. The greater reliability of railroad service, which is not subject to flood and ice interruptions, such as frequently occur on water routes.

4. The superiority of the railroad for passenger traffic and express business in the matter of speed and in the ability to haul freight long distance without breaking bulk.

In the matter of actual economy it has been demonstrated that under favorable conditions the railroads can haul coarse commodities like coal and ore at a rate as low as 4 mills per ton mile, with a profit. Such a rate will compare favorably with water rates on restricted channels, either artificial or natural. In order to realize the potential economy inherent in the low tractive resistance of water-borne loads, channels of ample cross-section, permitting the use of large boats at fair rates of speed, are needed. Such channels must not only provide a margin of depth over draft to allow for the "squat" of the boat when under way and to obviate the "drag" which results when the hull is too near the bottom, but also ample width to reduce wave wash and consequent damage to the banks. Observations recently made on the upper Hudson indicate that the squat of a boat under way is a function of the speed and depth of channel. In the case of the "Hendrick Hudson," a steamer 400 feet long and 9½ to 10 feet draft, the observed squat in water 135 feet deep at 22.5 miles per hour was 0.99 foot; at 11.5 miles per hour in the same depth the squat was only 0.15 foot. In water 14.4 feet deep the squat was 1 foot at 9.14 miles per hour, with a squat of over 3 feet. The effect of drag is to increase the power required to drive the boat at a given speed, as well as to limit the speed if channel depths are insufficient. The swell likewise is a function of depth of channel and speed of boat. In the case of the "Hendrick Hudson," the swell when running at 22.5 miles in water 135 feet deep was about 1 foot, and its effect inappreciable at a distance of 1,000 feet. In a channel 770 feet wide and 12 feet deep, while running at 11 miles per hour the swell at the shore measured 5.5 feet from hollow to crest. Ordinarily the provision of purely artificial channels of adequate dimensions to permit of free and easy navigation will involve so large a capital outlay as to make economical returns without a very large volume of traffic. Comparisons of rail and water rates are frequently misleading for the reason that no account is taken of the capital charges against the cost of channel improvements when these improvements are made at the expense of National or State Governments. A correct analysis of transportation charges on existing water routes in which capital and operating charges are included will reveal the fact that water rates are often higher than railroad rates. Government expenditures on water routes are not infrequently supported by the plea that even if they do not develop a traffic that will show returns, they serve the public indirectly by acting as a corrective on exorbitant railroad charges. Granting this to be true in certain cases, it would appear that a more certain and less expensive method for correcting railroad rates might be devised.

In Europe inland water transportation makes a better showing than in the United States, and water-borne traffic is still a factor in internal commerce. This is accounted for, partly at least, by the fact that in European countries centers of population and of industry were located on available water routes long before the advent of the railroads, and that trade accustomed itself to this mode of transportation. When the railroads made their appearance in the United States much of the country was still an undeveloped wilderness. The new agent of transportation with its flexibility and independence of topographical conditions permitted the establishment of towns and industries without reference to water routes, and at points where water transportation is economically impossible. The shorter hauls and denser populations of European countries also favor water transportation. Germany, with 200,000 square miles and 65,000,000 people, has one mile of railroad for each 1,600 population, as against one mile for each 400 in the United States. But even in Europe many of the old time canals are failing to show economic returns and are experiencing a declining traffic.

The fact that haulage charges are admittedly lower by water than by rail, and the phenomenal success of certain notable water routes is no doubt largely responsible for the popular fallacy that transportation by water is always cheaper than by rail. Unfortunately, haulage charges do not constitute the sole factor in the cost of transportation, and not always the largest part thereof. In average country a single track railway 100 miles long can be built and equipped for about $5,000,000. A canal of equal length, with single locks adapted for 300-ton barges, will cost about twice as much. On the assumption of one boat locked up and one locked down every hour for every day in the year, a fair assumption for a canal of this type, we secure the maximum traffic capacity of 2,500,000 tons per year. With sidings every 15 miles the railroad can handle 5,000,000 tons per year. To meet capital charges at 5 per cent, the canal would have to charge 2 mills per ton mile, as against ½ mill per ton mile by the railroad. For such commodities as are suitable for canal transportation, the difference of 1½ mills per ton mile to cover capital charges will go a long way toward meeting any difference in haulage cost in favor of the canal.

No more convincing evidence of the inability of the small canal to compete economically with the railroad could be afforded than the present state of decadence of the many canals constructed in the United States shortly before the advent of the railroad. The Morris, the Lehigh, the Schuykill, the Delaware and Raritan, the Delaware and Chesapeake, the Chesapeake and Ohio, and many others of like character have all succumbed to the competition of the railways. The Morris Canal, chartered in 1824 and completed in 1836, was built to carry anthracite coal to tidewater at New York, a distance of 107 miles, and designed for a maximum annual capacity of 1,000,000 tons. It passes through difficult country, surmounting an elevation of 900 feet above tide water by means of 22 inclines and 30 locks. The boat of 70 tons capacity, built in two sections for separation at the inclines, took 5½ days to make the journey to Jersey City. Although a triumph of engineering, it is little wonder that this canal was forced out of existence by the competition of the railways, three lines of which parallel the canal, each line with an annual traffic capacity of 10,000,000 tons, and capable of hauling train loads of 2,000 tons in 5 hours.

While small canals of the type in question are no longer capable of holding their own against the railroads, it must not be overlooked that their construction for the most part antedates that of their rival, and when undertaken they were a great advance upon transportation by the ordinary highways, and that they played no small part in the development of our country. Of all these earlier canals the sole survivor as a transportation factor is the Erie, whose resuscitation is now being undertaken by the State of New York at an expense of some $130,000,000, so as to permit of traffic by barges of 1,000 tons capacity on a depth of 12 feet. It is expected that this will result in a canal rate of two thirds of a mill per ton mile, a rate beyond the possibility of competition by the railroads. It remains to be seen whether the hopes of the supporters of the enlarged Erie Canal will be realized. As a connecting link between the commerce of the Great Lakes and the Atlantic seaboard the canal has tonnage possibilities which may justify the expenditures involved through savings to the public in transportation charges, but it must not be overlooked that at 4 per cent these savings should be $5,200,000 annually to cover capital charges. Evidently the tonnage must be heavy to effect such a saving. Whatever opinion may prevail as to the wisdom of the present project for enlarging the Erie Canal, the original canal was a fortunate and profitable undertaking, and contributed largely to the commercial supremacy of New York. Until the close of the Civil War the canal tonnage exceeded that of the competing railways, but after that it fell hopelessly behind, not so much because of a decline of tonnage on the canal, as because of the enormously rapid growth of the railway tonnage.

Transportation by water is subject to the same economic laws as any other method of transportation, and may or may not be more economical than rail transportation. Given ample natural waterways and an ample tonnage, water transportation will show an economy far beyond that of the railroad. A natural water route offers a free right-of-way without capital or maintenance charges, and gives the water route an advantage which the railroad cannot possibly overcome. An example of a successful inland water route is that of the Great Lakes, which afford over 800 miles of navigation from the head of Lake Superior to the foot of Lake Erie, obstructed only at the rapids of the St. Mary's River and at the narrows of the St. Clair and Detroit Rivers. Favored by ample channels and by an enormous tonnage of coarse freight, such as ore, coal, grain and lumber, the commerce of the Great Lakes has advanced by leaps and bounds in a manner truly impressive. In 1883, the tonnage at the Sault Canal was reported at 2,267,105 tons. In 1912, the canal handled over 70,000,000 tons, a more than 30 fold increase in 30 years. Practically all the tonnage in the Sault Canal is through freight between upper Lake Superior and lower Lake Erie points, and is hauled nearly 800 miles. Reduced to a ton mileage basis, the freight locked through the Sault Canal in 1912 represents 56,000,000,000 ton miles of traffic, nearly one fourth the total ton mileage of all the railroads in the United States in 1910. Huge as this tonnage may be, it does not cover all of the Great Lakes traffic, as it takes no account of tonnage between Chicago and lower lake ports, nor of tonnage between local points. This enormous traffic is carried on during but 7½ to 8 months of each year, navigation being stopped by ice for the

remaining four or four and a-half months of winter.

The growth of the Great Lake traffic has been so rapid as to seriously tax the ability of the Government to provide the needed facilities, especially lockage facilities at the St. Mary's River. In 1855 the State of Michigan completed the first locks, two arranged tandem, each 350 feet long and 70 feet wide, with 9 feet lift, thus opening a 12-foot navigation on the Great Lakes and connecting waterways. In 1870 the Federal Government entered upon a project for a 16-foot navigation, including a new lock 515 feet long and 80 feet wide, with a single 18-foot lift. This lock, known as the Weitzel lock, resulted in so rapidly increasing traffic that in 1886 a project for a 20-foot navigation and a new lock on the site of the old State locks, measuring 800 by 100 feet, was entered upon. The new lock, known as the Poe lock, was completed in 1896.

In 1907, a project for a still larger lock with a separate canal approach, to measure 1,350 by 80 feet, with 24½ feet of water on the sills, was adopted, to be followed in 1912 by a project for an additional lock of the same size. The last two locks are now under construction.

During the season of 1911, 20,242 vessels were locked through the American and Canadian canals in a total of 14,347 lockages. An average of 78 vessels daily passed the locks throughout the season of 237 days of navigation.

The continued improvement of the Great Lakes waterways has been accompanied by a continued increase in the size of the lake boats and a reduction in freight rates. In 1859, the largest vessels averaged 700 tons net register, with the 12-foot draft available. In 1890, when the 16-foot navigation had been finished, the average net registered tonnage of the large vessels had grown to 1,500 tons. With the present 20-foot navigation the largest vessels carry cargoes of 8,000 to 10,000 tons. In 1890, the average lake freight rate was 1.5 mills per ton mile; in 1912 it was reported at 0.67 mill per ton mile. These rates, of course, do not include capital charges, on account of improvements of the waterways, which are a gift of the Government. So large is the traffic, however, that the inclusion of capital charges would not increase the freight rate materially.

The astonishingly low freight rate on the Great Lakes is the result not only of the potential economy of water transportation, but also to the development of special transportation facilities for a more or less special transportation service. The bulk of the freight consists of ore, coal and grain, commodities which can be quickly loaded and unloaded, thus reducing terminal charges. Coal and ore chutes, car unloaders, hoisting and conveying machinery and numerous hatchways enable the lake carriers to take on or discharge cargoes with remarkable speed, so that little time is lost in port. Such a combination of favorable conditions as obtain in the transportation business of the Great Lakes is, of course, unusual, and the low freight rates are in consequence exceptional.

The mere existence of a natural water route is of itself no guarantee of an economical transportation service. Unless the route has traffic possibilities, it cannot show economic returns. The great volume of the traffic of the United States has for years moved, and still moves, on east and west lines. While the traffic of the Great Lakes is increasing yearly, that of the Mississippi River and its tributaries is at a standstill. Aside from obvious physical difficulties, due to floods and shifting channels, the direction of the river crosses the main arteries of commerce, and this of itself is a sufficient handicap to prevent the realization of the dreams of the waterways enthusiasts, who for years have been agitating a 14-foot channel from the Lakes to the Gulf, with ocean-going steamers tied to the banks. Fortunately, wiser counsel appears to have prevailed, and the danger of the Government committing itself to such a monumental economic error as a 14-foot channel has been passed for the time being. Why a depth of 14 feet should have been selected by these enthusiasts is difficult to understand, for it is suited neither to ocean nor Great Lakes traffic. While depth is always desirable, especially for ocean or lake steamers, economical transportation is possible with depths considerably less than 14 feet. The Mississippi River now and for some time has afforded a 9-foot navigation from its mouth to Cairo, 8 feet to St. Louis, and 4½ feet to Chicago. With practically the same depths, the Rhine enjoys an annual traffic of 54,000,000 tons by means of tows of barges. The barge of from 500 to 1,000 tons, with suitable towing boat, affords about as economical a system of transportation as any that has yet been devised, and if there are any traffic possibilities in the Mississippi River there is sufficient depth available to permit of their realization. Until the present possibilities have been exhausted it would be the height of folly to expend huge sums in securing greater depth, certainly not a depth of 14 feet, unsuited alike to either ocean or lake carriers. What is more important than a deep channel from Chicago to the Gulf is a channel of more moderate depth which can be developed not only on the Mississippi, but also on its main tributaries, and the development of a system of navigation by carriers adapted to that depth. A depth of 9 feet will afford economical transportation by tow boats and barges, and this depth is already available on the Mississippi from the Gulf to Cairo, and is being provided in the Ohio by a system of canalization. With reasonable expense this depth can be carried to Chicago via the Chicago Drainage Canal, and in this way a system of internal waterways placed at the disposal of the public sufficient for a long time to come. Whether such a system will ever prove economical from a business standpoint is doubtful, but until traffic justifies, no greater depth than 9 feet is warranted.

In the United States the railroad has unquestionably won out as the chief agent for inland transportation, by giving better service as well as frequently the most economical when all factors are included. This does not mean that water transportation is doomed. Under proper conditions, water routes are economical agents of transportation, and with increase of population and of traffic the field for inland water transportation will increase.

(*To be continued.*)

The New Seismology*

Earthquake Study as a Branch of Physics

By J. Milne †

For very many years past in Italy, and to a lesser extent in other countries, earthquakes had been recorded, while a few private individuals collected and analyzed earthquake statistics. These, however, were the days of seismoscopes and the old seismology. The new seismology did not come until macroseisms had been measured and teleseisms had been discovered. With their arrival new lines of physical, and particularly geophysical, research were opened for exploitation. Commencing in Japan, the desire to record and discuss the felt and unfelt palpitations of our earth spread like an epidemic round the world. In 1880 the Seismological Society of that country was founded, and the twenty volumes which it issued contain initiatives for very many of the investigations carried out since that date. When this society ceased to exist the Japanese government established an Earthquake Investigation Committee, which up to date has published more than eighty quarto volumes.

In the early days attention was first directed towards obtaining instruments which would give actual measurements of earthquake motion. Steady-point instruments were devised, and, for earthquakes we feel, are now in use throughout the world. From a knowledge of the actual nature of earthquake motion derived from these instruments, new rules and formulæ for the use of engineers and builders were established. To test the suggested new departures in building and engineering practice, structures in brick and other materials were fixed upon platforms actuated by powerful machinery and subjected to movements closely corresponding to those of heavy earthquakes. The results of these investigations in Japan and other countries have been extensively applied in the construction of piers for bridges, tall chimneys, walls, ordinary dwellings, embankments, reservoirs, etc. Inasmuch as the new types of structure have for very many years withstood violent shakings, while ordinary types in their neighborhood have failed, it may be inferred that much has already been accomplished to minimize the loss of life and property.

The application of seismology to the working of railways, particularly in Japan, led to the localization of faults on lines, and alterations in the balancing of locomotives. The result of the latter has been to decrease the consumption of fuel.

Later, instruments were devised to record earthquake motion which cannot be felt, with the result that a person living in any one part of the world can record and obtain definite information about any *large* earthquake originating even so far off as his antipodes. These records of the unfelt movements of earthquakes have from time to time indicated the position, the time of occurrence, and, what is of more importance, also the cause of certain cable interruptions. The practical importance of this latter information, especially to communities which may by cable failures be suddenly isolated from the rest of the world, is evident.

The many occasions on which earthquake records have furnished definite information respecting disasters which have taken place in distant countries, corrected and extended telegraphic reports relating to the same, is another illustration of the practical utility of seismic observations. Seismograms have frequently apprised us of sea waves and violent earthquakes in districts from which it is impossible to receive telegrams, while the absence of such records has frequently indicated that information in newspapers has been without foundation or at least exaggerated. Localization of the origin of these world-shaking earthquakes, besides indicating sub-oceanic sites of geological activity, indicates positions where the hydrographer may expect to find unusual depths. They have also shown routes to be avoided by those who lay cables.

Seismograms of unfelt movements throw light upon what have but recently been regarded as unaccountable deflections in the photograms from magnetographs, barographs and other instruments sensible to slight displacements. They have also explained unusual rates in certain timekeepers.

Among the very many scientific results which the new seismology has contributed to science is that it has given us the velocities at which motion is propagated in various directions through the world. Until these observations had been made our knowledge respecting the interior of the earth chiefly related to its density and temperature. Now we know much about its rigidity.

With the object of increasing our knowledge of teleseismic disturbances, in 1896 the British Association, with the assistance of the British government, communicated with many foreign states and colonies suggesting that they should establish a certain type of seismograph. The result has been that the British Association now enjoys the co-operation of fifty-nine similarly equipped stations which are fairly evenly distributed over the world. The general outcome from this and the work carried out in Japan is that nearly every civilized country in the world has had its attention directed to this new departure in geophysics and has established seismographs.

In the last-mentioned country observers are to be found in most towns, and many instruments have been installed to record macroseisms and teleseisms. The annual outlay for earthquake work in that country is about $25,000. Russia, for the support of a system extending over its vast territories, expends a similar amount. Italy, which is the oldest country for recording earthquake phenomena, is covered with stations. Austria, France, Switzerland, Chile, the United States of America, the Balkan states and the small states of Central America each have their organized systems, while in Germany we find the headquarters of the International Seismological Association. This is supported by yearly contributions of about $8,000 from twenty-two countries. The headquarters of this body is in Strassburg, but it also controls stations in Beirut and Reykjavik. In Great Britain teleseisms are now recorded in thirteen different places. Three of these stations are owned by private persons, but the one in the Isle of Wight is largely supported by grants from the Royal Society, the British Association and Mr. M. H. Gray. The remaining nine are attached to existing observatories or other institutions.

* Reproduced from *Nature*.

†The death of Prof. Milne was announced in the issue of August 16th of the SCIENTIFIC AMERICAN.

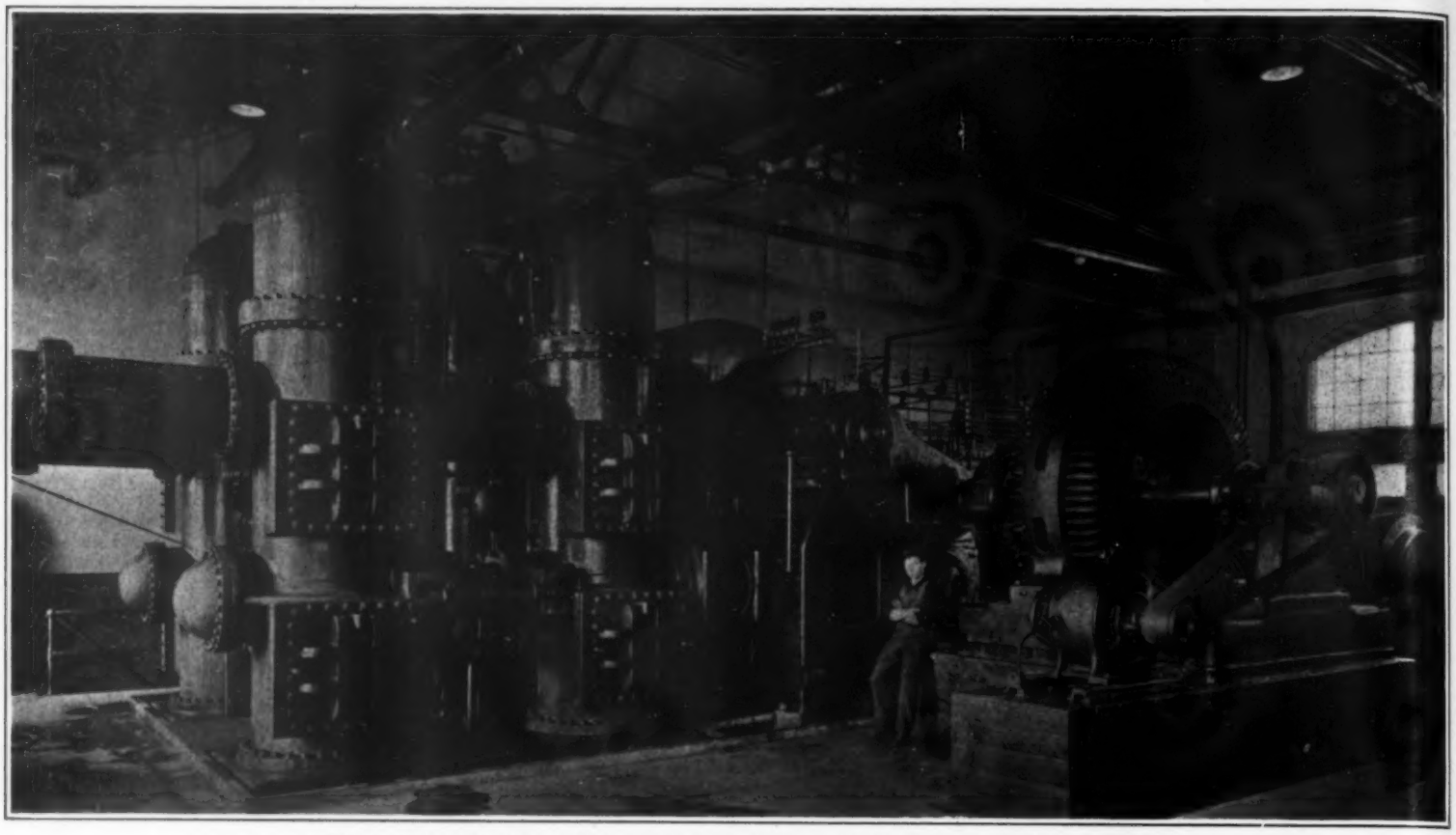

Fig. 1.—6,000,000-gallon variable stroke pump driven by 600 horse-power synchronous motor.

The Industrial Use of Synchronous Motors by Central Stations*

Bettering Service by Co-operation between Producer and Consumer

By John C. Parker

It is desired in this paper to point out a few specific applications that may be made of the synchronous motor, and the means of securing co-operative effort between the central station and its customers for the purpose of securing synchronous motor load and thereby bettering service.

It may be recognized that in general the customer of a distributing company has little technical interest in the use of synchronous equipment, since it is somewhat more expensive than induction motor equipment, does not lend itself readily to extremely small unit installation, and is, even with more modern apparatus, slightly less substantial and easy to operate. On the other hand, on the larger units these difficulties are of less significance, and therefore we may look for industrial applications of synchronous motors where relatively large concentrated power applications occur, possibly supplemented by, but in general differentiated from, group and individual motor drive distributed throughout a manufacturing plant. It will, therefore, be the case that such applications must be made on large centralized equipment, such as air compressors, refrigerating machines, pumps, etc., rather than on individual machines, or in those places where the industry depends on one centralized power supply using mechanical distribution throughout the plant; such industries being, for example, the smaller milling concerns, where all of the manufacturing processes are correlated, giving no diversity factor on the different machines and thereby most readily lending themselves to a mechanical power distribution, all of which operates all of the time when the mill is in commission. Such a mechanical distribution in general offers high efficiency of distribution with a not excessive first cost and maintenance, and with fairly close synchronizing of the different machines driven, so that in such a case individual induction motor installation with electric distribution of power is not economically justified.

Obviously the synchronous motor in industrial use will not find its place where frequent starting and stopping are required, nor where the starting must be done under full load.

In the cases of relatively large centralized power utilization, the consumer's motive for synchronous motor application is found either in a rate schedule favorable to unity power factor or leading load, in a sharing of the expense of the initial installation by the central station company, or in a special arrangement into which the central station enters for a class rate made lower than the rate offered for induction motor service in consideration of the improvement of distribution conditions, and offered only where such an installation will prove advantageous to the central station company.

Practically all modern systems of charge for electric service are based on the maximum demand in conjunction with the kilowatt-hours, either in the form of a direct charge for power and another direct charge for energy, or on the load factor distributed over a period of time, in which case the charge comes back to either a recorded demand charge or the rating of the connected apparatus. A metered system of demand seems to be distinctly preferable.

By having such a metered demand based on the kilovolt-amperes rather than on the kilowatts, the consumer has a material interest in keeping the power factor as near to unity as possible. This is particularly the case where energy is supplied from a hydroelectric enterprise over a long distance transmission line. In such case a kilovolt-ampere basis of charge is, the writer believes, the rule, and the incentive to the customer to make synchronous installation is a matter of anywhere from ten to thirty per cent of the annual cost of power.

An additional feature, which in the writer's practice is being incorporated into industrial synchronous motor applications, is the use of automatic potential regulators for holding constant voltage at distant points in the transmission line, either with or without inductance inserted in series with the line.

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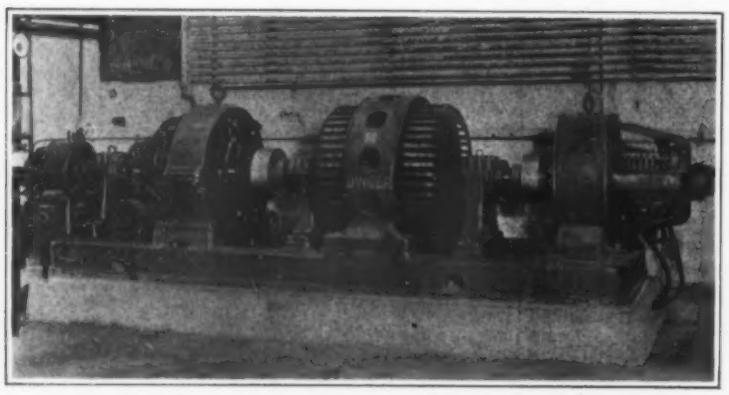


Fig. 2.—Synchronous motor-driven battery charging set.

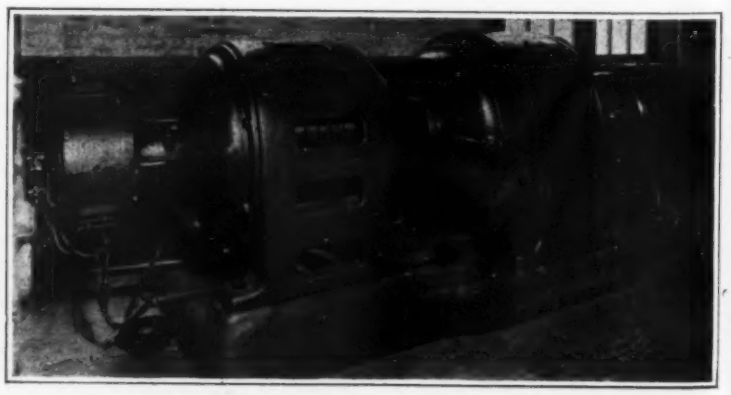


Fig. 3.—Synchronous motor-driven set for refrigerating machine.

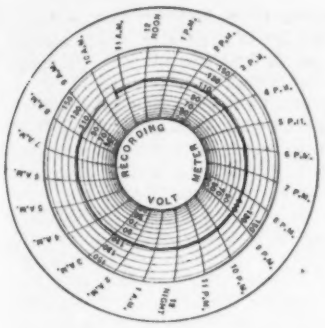


Fig. 4.—Voltage at refrigerating plant. Automatic voltage regulator cut out. Power factor 75 p. c.

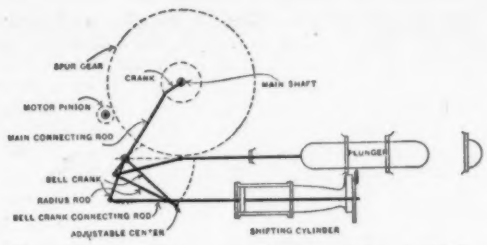


Fig. 5.—Line diagram of 6,000,000-gallon variable stroke pump (see Fig. 1).

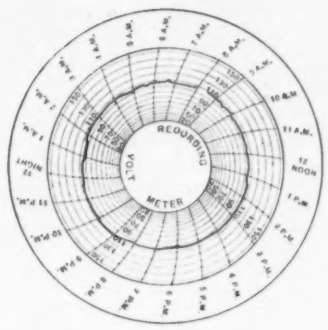


Fig. 6.—Same circuit with automatic potential regulator in operation.

Where the aggregate leading quadrature kilovolt-amperes which it is practicable to get connected to the lines is less than the aggregate lagging quadrature kilovolt-amperes due to induction load, it is manifestly undesirable to insert a series inductance, since the latter would serve to reduce the power factor of the feeder load and maintain a certain minimum potential drop; but even in such a case the synchronous motor with constant potential relay is useful in supplying the leading kilovolt-amperes as the lagging kilovolt-amperes of the induction motor load increase, and *vice versa*, thus at all times keeping the condition of the feeder, so far as wattless kilovolt-amperes are concerned, at least as good as the best condition obtaining prior to the installation of the synchronous equipment, and throughout the major part of the day very much better than those conditions.

Where the synchronous quadrature demand can be made in excess of the lagging quadrature demand from induction motors, it then becomes desirable to put inductance in series with the feeder, thereby overcoming drop due to the in-phase amperes operating in conjunction with the line resistance.

The use of this remote potential control has certain advantages over control by station regulators. First, it combines the two functions of load carrying and of regulation in one piece of apparatus. Second, it is independent of certain approximations in regard to the feeder characteristics; and third, it is independent of the distribution of the load along the feeder at varying hours of the day.

This last factor is of very considerable importance, since a station regulator with a compensator to simulate the line impedance must be arranged for an arbitrarily assumed load distribution, while on most distribution systems in the larger cities, at least, the alternating current feeders traverse a belt of residential territory surrounding the central direct current district, and then pass into the outlying industial district. Where one set of feeders is maintained for both the residential and industrial districts, the center of load shifts between five and six o'clock P. M. from the industrial load of the outlying districts to the lighting load of the residential districts, and therefore voltage regulator compensation which is carried for one hour of the day is inaccurate for another hour; whereas, with the synchronous motor used as a potential regulator, a motor at all times endeavors to hold strictly constant voltage at the point at which the potential relay is applied to the transmission line.

In view of the fact that such potential regulating relay is only concerned with the voltage delivered to it, a series of such installations may be installed along the length of a feeder with inductances of a simple type inserted into the feeder at points so chosen between the synchronous motor service taps as to have the potential at two adjacent inductances equally high above and below the voltage for which the regulator is set, thereby getting the flattest voltage curve between these inductances and very considerably better regulation over the whole length of the line.

As the voltage distribution curve along a feeder carrying uniformly distributed load of uniform character is a parabolic function of distance, it is manifest that the segmentation of voltage regulation of such series inductances reduces the variation of potential to a function which is a square of the length of the segments of the line, so that this segmental regulation with but slight multiplication of the segments makes for a material betterment in the conditions throughout the circuit.

It is perhaps hardly necessary to indicate that what we are interested in is primarily leading quadrature kilovolt-amperes, and that these can be got with less and less additional investment and operating losses as the power factor approaches unity in a machine where power factor correction and shaft load are combined in one motor. This points to the desirability of having connected to the lines as many and as large synchronous motors as may be commercially practicable, rather than combining the power factor correction for a given circuit all in one machine of limited size, or in a synchronous motor used merely for power factor correction.

As to the applications that may be made of the synchronous motor, it may be said that the simplest application is as the driving end of a motor-generator set, where a variable direct-current voltage is desired for such purposes as battery charging in large garages, and speed control of refrigerating apparatus. The illustrations show two such sets, one of 268 kilovolt-amperes capacity at 85 per cent power factor, driving two generators, one of which is used in charging pleasure vehicles and the other of the higher voltage commercial trucks. The other illustration referred to shows a four-unit set, consisting of a 210-kilovolt-ampere, 70 per cent leading power factor synchronous motor driving a 25-kilowatt constant voltage generator for general power purposes, a small exciter, and a 90-kilowatt direct-current generator, the field excitation of which is varied to supply variable voltage to the armature of the motor operating a refrigerating machine.

A type of application but little used is that in which the driven apparatus itself is adapted to variable output, and to synchronous motor starting. One such case is shown in the illustration of a 6,000,000-gallon pump operated by a 600-horse-power, 375-volt synchronous motor. In this case the pump stroke is made variable by means of a linkage hydraulically operated, whereby the piston stroke may be reduced quite to zero and the no-load torque thereby brought well within the pull-in torque of the motor. After the motor is in operation, the stroke of the pump may be varied at will, so as to deliver anything from zero up to 6,000,000 gallons per 24 hours. The writer is of the opinion that a great many synchronous motor applications may be found where similar adaptations of the mechanically driven apparatus to the requirements of synchronous drive may be accomplished.

As an indication of what may be looked for in this line, there has been developed an air compressor which, operating at constant rotative speed of the shaft, varies its output by air valves operated by a mechanism similar to that of a corliss engine. The corliss gear varies the cut-off on the intake, and thereby limits the work done per stroke, while the compressor may be relieved entirely of load at starting by blocking the valves open.

Another method of accomplishing the same result has been suggested by Mr. I. Lundgaard, who recommends the adaptability of constant speed motor drive to variable output for air and ammonia compressors by means of an adjustable clearance space to be secured through the use of small cylinders with stop pistons, or through a series of chambers communicating with or cut off from the clearance space by separate valves. The combination of such an arrangement with a by-pass valve obviates the necessity for variable speed and high starting torque, and through such arrangement the range of industrial application of synchronous motors is very widely extended.

The Present Appearance of Some Temporary Stars*

Preserving a Record for Future Observers

By Prof. E. E. Barnard

The so-called temporary stars are among the most interesting celestial bodies we have to deal with. In general these objects have made their appearance suddenly, where previously no star was known to exist. The mystery of their origin was a fascinating one. Was it possible that this sudden appearance in a blank space was an actual creation of the star? This prevalent idea was only partly removed when Nova T Coronae bor. was shown to have been a previously known star of the 9.5 magnitude. From this very fact, however, I think it was believed by some that T Coronae bor. was not a true nova.

Formerly these strange stars were seen only at great intervals of time. In most cases they must have attained to conspicuous naked eye visibility to be detected at all.

In recent years the introduction of photography has shown that the novae are not so rare as was at first supposed, and that with a close watch of the sky their discovery may be as frequent as one or more a year; and if one takes into account those which probably never become as bright as the 12th or 13th magnitude and, because of their faintness, are not found, there must be a far greater number appearing every year.

Photography has also removed any doubt as to their earlier existence as small stars by identifying with certainty some of them on photographs made previous to their outburst. Indeed, it is more than probable that these stars all return to their original condition in a comparatively short time, the outburst being no doubt only a brief epoch in their life history, and whether it is to be repeated at some future time is not known.

There is a question whether these stars are originally all of a similar nature, peculiar to themselves, which makes an outburst in the course of time inevitable, or whether they are only ordinary stars of the sky any one of which may become a nova. At present we have too little information on the subject upon which to base an opinion.

There is one fact in connection with these stars, however, of which we may be assured and which itself is of the greatest interest to us. There must be thousands of old novae which are bright enough to be observed if we could but identify them. There are now quite a number of these bodies that have made their appearance in the last half century which are still visible in powerful telescopes. For a good many years I have kept a few of these objects under observation with the large telescope[1] in the hope that something might be learned about them that would help to solve the mystery of their sudden appearance and of the unique phenomena they have shown. It is possible also that a study of the present conditions of the known novae, especially in the case of the older ones, may lead us to some means of identifying some of the unknown novae that must certainly be scattered over the sky in large numbers. Probably most of these stars have dropped out of sight and out of mind of observers in general. It would seem, therefore, that a brief account of the present appearance of some of these objects might be of general interest. With this end in view I have prepared the following notes from my most recent observations of some of these bodies.

Perhaps a brief statement in connection with their discovery may not be out of place. The references have been confined to my own papers on

* Reprinted from *Astronomische Nachrichten*, No. 4655.

[1] The 40-inch Yerkes refractor.

the different novae included in the following notes:

Nova T Coronae bor. of 1866. *Birmingham's* Star.
1900.0 α 15h. 55m. 19.3s. δ + 26° 12′.2.

This object was discovered by *Birmingham* near Taum in Ireland. It suddenly appeared about 1866, May 12th, and rose to the 2nd magnitude. Observations soon showed it to be identical with BD + 26°2765, which had previously existed as a 9.5 magnitude star. It finally returned to its original magnitude and seems to have shown no peculiarities since. It was the first of these bodies to be observed with the spectroscope, and showed to *Huggins* a spectrum that seems to be characteristic of this class of stars.

A few years ago I observed this object carefully and have looked at it several times since. The main observations are given in *Astrophysical Journal*, vol. 25, p. 279, for May, 1907. At these observations the star was 9.4 magnitude on the BD scale, and apparently colorless. It did not differ in any way in focus or appearance from the ordinary star. The out of focus image, however, was not examined. This star evidently returned to its former condition a good many years ago. A careful spectroscopic study of it at present would perhaps give information of value in connection with the life history of such stars.

Nova Cygni of 1876. *Schmidt's* Star.
1900.0 α 21h. 37m. 47.2s. δ + 42° 23′.1.

This star when first seen on the evening of 1876, November 24th, by *Schmidt* of Athens was between the 3rd and 4th magnitude. Its appearance was probably sudden. According to *Schmidt* it was not visible a few evenings previous. The decline in its brightness was at first rapid and then very slow. It is now of about the 14½ or 15th magnitude and has not changed in brightness in the past ten years. My last observation of it was 1911, October 29th, when it was about 15th magnitude. Its appearance is distinctly hazy and it requires a slightly longer focus than the ordinary star. It is probably slightly variable in its light. M. N. 62.405–419, 72.525–534.

Nova Andromedae of 1885. *Hartwig's* Star.
1900.0 α 0h. 37m. 15.1s. δ + 40° 43′.2.

This star made its appearance about 16″ preceding the nucleus of the Great Nebula of Andromeda where no star was known before. The accounts of the time of its appearance are rather conflicting. Various observers report having seen it in the early part of the last half of August, 1885, when it was as faint as the 9th magnitude. Our definite information, however, dates from *Hartwig's* announcement of it on August 31st, when it was of the 6th magnitude.

The star soon faded and in a few months' time had disappeared. It was invisible to Prof. *Hall* with the 26-inch telescope at Washington in March of 1886.

I have looked for this object a number of times in the past 20 years with both the 36-inch telescope of the Lick Observatory and with the 40-inch of the Yerkes Observatory, but nothing has been seen of it. The last observation was 1912, November 15th, when under good conditions nothing could be seen of the star with the large telescope. Of course its position in the brightest part of a bright nebula would prevent its being seen unless it were much brighter than the limit of the telescope on a dark sky. Photography is also handicapped by the brightness of the nebula which would prevent a long exposure that might otherwise show the star. See Aph. J. 8.226 for other negative observations.

In September, 1885, *Engelmann*, at Leipzig, measured the position of the nova with respect to the nucleus:

P. A. 256°.14 Dist. 16″.33 (8 obs.). See A. N. 2683.

Nova Aurigae of 1891. *Anderson's* Star.
1900.0 α 5h. 25m. 34.0s. δ + 30° 22′.2.

This star was discovered visually by the Rev. *Thos. Anderson* at Edinburgh, 1892, January 23rd, and announced by him to Dr. *Copeland* January 30th. Photographs by *Max Wolf* and at Harvard College Observatory show that the star must have appeared between 1891, December 8th and December 10th, from which last date it was visible on the H. C. O. plates until the time of its discovery by *Anderson*, having attained its greatest brightness of 4½ magnitude about December 20th. It was the first star of this class, through the aid of photography, to show the remarkable and complicated spectrum that seems at certain stages of their existence to belong to these stars, *Huggins* observations of the spectrum of Nova Coronae bor. having been visual and necessarily primitive in character. Observations of the nova, with a diagram, are given by Prof. *Burnham* in M. N. for April, 1892.

The star soon faded to a low magnitude. On April 26th, 1892, when last observed by Prof. *Burnham*, it was 16th magnitude and fading at the rate of 0.18 magnitude a day. (M. N. 53.58–60.) In August of the same year it had again risen to the 9th or 10th magnitude, after which it once more diminished, and seems to be still slowly fading. On 1901, October 22nd, it was 13th magnitude, and at my last observations on 1912, November 16th, it was 14th magnitude. Its image is ill defined and seems to require a somewhat longer focus than that of the ordinary star. M. N. 62.61–65.

Nova Sagittarii of 1898. Mrs. *Fleming's* Star.
1900.0 α 18h. 56m. 12.6s. δ — 13° 18′.2.

This is one of the many discoveries in this line made by the late Mrs. *Fleming* of Harvard College Observatory, who discovered the star on a photograph taken March 8th, 1898. It was then 4.7 magnitude. My observations began 1899, May 10th, when the star was about the 11th or 11½ magnitude. In recent years this object seems still to be slowly fading or perhaps nearly stationary in its light. It is always hazy and ill defined. My last observations were made on 1912, July 16th, when the star was 15th magnitude.

See A. N. 4136 (star 4 of the diagram there given has been seen since that paper was written and seems to be variable).

Nova Persei of 1901. *Anderson's* Star.
1900.0 α 3h. 24m. 24.1s. δ + 43° 33′.7.

The history of this wonderful star which was also discovered by the Rev. *Thos. Anderson* (on 1901, February 21st, at Edinburgh[2]), and which was perhaps the brightest nova since that of 1572, is so recent and so fully written up and familiar to everyone that I will confine my remarks to its present condition. The star at present is colorless. There is nothing in its appearance or focus different in any way from the ordinary star. My last observation was 1912, October 26th. Its magnitude was then 12.4. Observations on September 8th and October 15th made it 12.1 and 12.0 magnitude, respectively. These two last values are probably the more accurate. Measures of focus on September 8th and October 15th showed no difference from that of the ordinary star.

According to Prof. *E. C. Pickering* (Aph. J. 16.339 till 340) the nova probably existed previous to its outburst as a small variable star (whose light fluctuated between 13th and 14th magnitude) which appears on numerous H. C. O. plates as far back as 1890, October 26th.

Aph. J. 14.151–157, 16.183–185 and 340–341; A. N. 3796, 3829, 3888, 4220 and 4285.

Nova Geminorum of 1903. *Turner's* Star.
1900.0 α 6h. 37m. 49.0s. δ + 30° 2′.7.

This star was discovered by Prof. *H. H. Turner* on photographic plates taken at Oxford, England, 1903, March 16th. It was then on its decline and has continued to fade up to the present time. My last observation of it was on 1912, October 15th, when it was, by estimation, 16th magnitude. By comparison with star 7 close preceding it, for which Mr. *Parkhurst's* measures give magnitude 15.27, the nova was 16.3 magnitude. It was too faint to tell anything of its focus. From the present indications the star will perhaps eventually pass out of reach of the 40-inch telescope. M. N. 66.355–361; Aph. J. 17.376–377.

Nova Aquilae of 1905. Mrs. *Fleming's* Star.
1900.0 α 18h. 56m. 49.0s. δ — 4° 35′.3.

This star suddenly appeared between the dates 1905, August 10th and 18th. It was discovered by Mrs. *Fleming* of Harvard College Observatory on a photograph taken on the latter date when it was of the 5th magnitude. It faded rapidly.

During the present year, 1912, I have tried several times to see this object with the large telescope, especially on the night of 1912, July 13th, when, under good conditions, no trace of it could be seen. It has passed beyond the reach of the 40-inch telescope and must now be less than the 17th magnitude. Aph. J. 22.358.

Nova Lacertae of 1910. *Espin's* Star.
1900.0 α 22h. 31m. 45.1s. δ + 52° 11′.9.

This star was discovered visually by the Rev. *T. E. Espin* in England on 1910, December 30th, when it was about 7th magnitude. Photographs made at Harvard College Observatory showed that the star had suddenly appeared between 1910, November 17th and 23rd. On the last date it was 5.0 magnitude. Photographs of the region in which it appeared taken as far back as 1893, October 11th, showed the object as a star somewhat fainter than the 13th magnitude.

My last observations were on 1912, December 31st, when its magnitude was 12.5. It then presented the appearance of a very small nebula, less than 2″ in diameter, of a bluish white color. The focus was 5 millimeters greater than for an ordinary star. When in best focus it was still very ill defined. M. N. 72.659–674; A. N. 4468.

[2] When discovered the star was bluish white in color and of 2.7 magnitude. It increased rapidly in brightness until it outranked every star in the northern heavens.

Nova Geminorum No. 2 of 1912. *Enebo's* Star.
1900.0 α 6h. 48m. 25.0s. δ + 32° 16′.0.

This star was discovered visually by *Enebo* at Dombaas, Norway, on 1912, March 12th, when it was about 4th magnitude.

Photographs taken at Harvard College Observatory (that never-failing source of valuable information concerning these bodies) show that it must have appeared between March 10th and 11th. A photograph taken by Dr. *Max Wolf* on 1909, January 20th (A. N. 4564) shows the nova as a small star of the 13th magnitude close south of a much brighter star. Upon examining the nova on 1912, March 18th, with the 40-inch telescope, a faint star was seen close north of the nova and almost lost in the brightness of the latter. This faint star was the "much brighter star" of Dr. *Max Wolf's* photograph of 1909. Following are measures of its position:

Nova and faint star north:

1912 March	18	17°.16	12″.00
April	8	16°.68	12″.25
	21	18°.63	11″.88
	22	18°.05	12″.02
		17°.63	12″.04

The small star was difficult on account of the brightness of the nova, and was estimated to be 15th magnitude. In later observations, since the nova has diminished in light, the small star is conspicuous and is probably brighter than the 13th magnitude. Some other stars near have also been measured.

My last observations of the nova show that it is just now fluctuating in brightness. By comparison with the BD stars +32°1433, +32°1437 and +32° 1442 the following observations of its brightness have been made (besides a number of earlier determinations):

1912	Nova m.	1912	Nova m.	1912	Nova m.
Oct. 29	7.7	Nov. 10	8.2	Nov. 17	7.5
Nov. 9	8.1	15	8.2	24	8.2

Later observations are:

1912	Nova m.	1912	Nova m.	1913	Nova m.	1913	Nova m.
Dec. 8	7.4	Dec. 22	8.6	Jan. 3	8.3	Jan. 12	8.3
21	8.2	28	8.4	4	8.0		

Though the nova showed the presence of the *Ha* crimson image in its earlier stages (M. N. 72.675) it did not, up to 1912, December 21st, show any difference in its focus from that of an ordinary star. On the last five dates the seeing was too poor to tell anything of the focus.

Nova Cassiopeiae of 1572. *Tycho Brahe's* Star.
1900.0 α 0h. 19m. 0.2s. δ + 63° 34′.7.

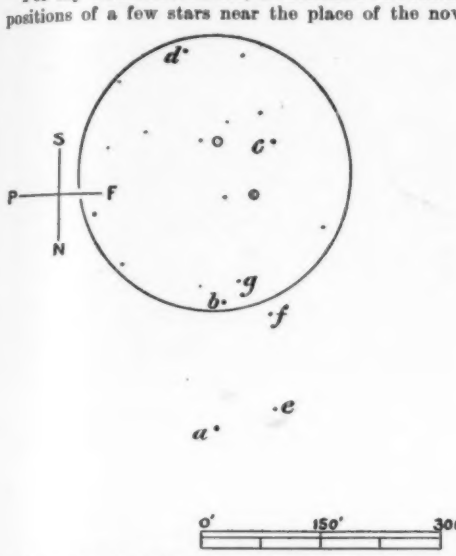
In Monthly Notices 21, Mr. *F. R. Hind* gives the position of the great nova of 1572. This place he determined from *Tycho Brahe's* observations to be: 1850.0 RA. 0h. 16m. 18.2s. NPD. 26° 41′ 55″. *Hind* says that *Tycho's* own determination of the position of the star differed from this place by +5.4s. in RA. and —1′.2 in NPD. In examining the region *Hind* found two small stars that would each indifferently represent the place of the nova of 1572. The first of these was in the position 1850.0 RA. 0h. 16m. 20.9s., NPD. 26° 38′.8 of the 11–12 magnitude. The second, which was rather fainter, was in 1850.0 RA. 0h. 16m. 29.4s. NPD. 26° 42′.0. *Hind* states that the second star was the more suspicious of the two and that they both would require watching. Their positions for 1855.0 would be:

	h.	m.	s.		
star 1	α 0	16	37.1	δ	+63° 22′.9
star 2	0	16	45.6		+63° 19′.7

This winter I have examined the place of the nova as given by *Hind*, with the hope that some peculiarity in the appearance of the star might lead to its identification. There is no reason, however, for supposing that the nova should be one of the stars indicated by *Hind*, except for proximity of position. There are many faint stars in the region, any one of which could lay equal claim for such reason. From the extraordinary brilliancy of the nova at its outburst in 1572 there would be some slight reason to think that it may have been of considerable magnitude before the outburst — there is no reason to suppose that a nova returns to a fainter magnitude than that of its original condition. This might lend a little color to the possibility of one or the other of *Hind's* stars really being the nova. Neither of these, however, from a visual inspection, shows anything peculiar. The fainter (*c*), which *Hind* favored somewhat, is slightly yellowish, and in a nova a few years old, this would at once decide against it, for they all seem to be white or bluish white in their

later stages — such, for instance, as Nova Persei. This criterion, however, may fail because of the long interval of time since the great nova appeared. There is at least a possible suggestion of color to Nova Coronae bor. at present, though its general appearance is white.

For my own convenience, I measured the relative positions of a few stars near the place of the nova,



The circle shows the size of the field of the 40-inch telescope. Hind's place of the Nova is designated by ○, Tycho's place by ◐.

on one night each, and have connected them with the 8.5 magnitude star *A*, BD +63°38. These measures follow:

A and *a*	1912 Dec. 22	P.A. 151°.3 (3)	Dist. 272″.0 (8)
a and *b*	22	177°.8 (5)	160″.0 (8)
b and *c*	28	164°.0 (5)	211″.8 (8)
c and *d*		$9\,\Delta\alpha\cos\delta$ 115″.1 (3)	$\Delta\delta$ 108″.9 (3)
c and *d*	31	P.A. 226°.5 (5)	Dist. 158″.4 (8)
b and *e*	22	24°.5 (5)	154″.7 (8)
b and *f*	22	76°.2 (5)	78″.4 (8)
b and *g*	22	147°.8 (5)	32″.0 (10)

The numbers in brackets represent the number of settings of the wires.

Roughly, the positions of the principal stars shown on the chart are:

Epoch 1855.0

	h. m. s.			
A =	α 0 16 15	δ	+63° 29′.8	= BD +63°38
a =	0 16 34		+63° 25′.8	
b =	0 16 35		+63° 23′.1	= *Hind* 1
d =	0 16 27		+63° 17′.0	
c =	0 16 44		+63° 19′.7	= *Hind* 2

The following magnitudes were estimated on 1912, December 9th and 22nd:

	m.		m.
a =	12.7	*e* =	12.3
b =	11.7 white	*f* =	12.8
c =	11.9 slightly yellow	*g* =	13.5
d =	12.1 white		

On December 31st *d* was estimated ½ magnitude less than *c*.

The following focal measures were made on December 31st:

b 5.7 mm. (4) White. Perhaps not quite so well defined as *c*.

c 5.8 mm. (6) Fairly well defined.

d 6.2 mm. (4) Pale white. Not well defined.

These measures show that the difference in focus was inappreciable. There was nothing peculiar in the out of focus image of any of the stars.

Hind's and *Tycho*'s positions of the nova for 1855.0 are:

	h. m. s.		
○	α 0 16 34	δ	+63° 19′.7 (*Hind*)
◐	0 16 40		+63° 20′.9 (*Tycho*).

If we locate on the chart the position as determined by *Hind* from *Tycho*'s observations, and also from the position deduced by *Tycho* himself, we find that there is still another star (*d*) which has an equal claim with *Hind*'s first star, by being as close to the assigned place. The nearest considerable star is *c*. There are two very faint stars that fall quite close to *Hind*'s place, either of which might be the nova.

In the chart I have drawn a circle around the immediate region of the nova, to represent the field of view of the 40-inch telescope (5½′ ⌀). In this are sketched, by estimation, some of the faint stars that were visible, the faintest shown being about 16th magnitude. There is nothing peculiar in the appearance of any of these small stars.

I also searched around this region for some 15′ for any star that might, from its appearance, be the nova.

P. S. On 1913, February 8th, with good seeing, and at the proper focus, the *Ha* image of Nova Geminorum No. 2 was clearly seen. It was small and sharp and intensely crimson, and was surrounded by a greenish blue halo some 3″–4″ in diameter. The normal focus, however, was not different from that of an ordinary star.—E. E. B.

Heredity and Genius*

By Charles Kassel

At intervals during the past few years the present writer has published statistical studies upon the subject of genius as related to physiognomy, stature, hair color and structure and fertility. Recently, by the same methods, he has investigated the question that lies at the root of the eugenics movement—the inheritance of talent. The purpose was to learn whether our celebrated men and women have been scions, for the most part, of distinguished families or offshoots of lowly stocks, believing the conclusion deduced would tend to show whether the characteristics that make for greatness are acquired or inborn.

Using as a basis for work Prof. J. McKeen Cattell's catalogue of names as published in the *Popular Science Monthly* for February, 1903—laboriously sifted as that invaluable list was from the chaos of biography—we have searched out the ancestries of the world's thousand most famous personages and have tabulated the results.

Of the thousand individuals we find that 510 were of noteworthy and only 208 of obscure descent. As to 192 names no data were afforded by our authorities. In the larger lists are included those of noble descent and those whose progenetors held positions in society indicative of talent, while in the smaller are included children of ministers, lawyers, physicians, and schoolmasters without special prominence.

If we add to the list of those who were of noteworthy ancestry the names of the men and women who were children of parents belonging to professions requiring intellectual capacity, we increase the number to 584, for of those ranged with the obscure ancestries 30 were children of ministers of religion, 11 of musicians, 5 of sculptors and painters, 4 of physicians, 11 of lawyers, 4 of Government clerks, 3 of notaries, in a day when the duties of notaries differed widely from those of modern officials of the name, 2 of scriveners and 4 of schoolmasters. So, too, if it be just to add to the larger table of names those who were the children of "rich" or "well-to-do" parents, though without other mark of capacity, we may enlarge the number in that list to 610 names. Of those remaining still in the list of obscure ancestries, 26 were children of merchants, of whom no few were of more than ordinary mark, if only in a talent for affairs; but these we retain among the obscure.

So far as shown by our data, only fourteen in the thousand were children of farmers, five were children of peasants, forty-nine of artisans in the various skilled handicrafts, five of sea-faring men and one was the child of a laborer. The butcher, upon whose business humanity has always looked somewhat askance, can claim the parentage of only two distinguished individuals.

It is thus plain that the number of ancestries in the list of one thousand which were of a character wholly to exclude the idea of ability beyond the ordinary, are few—but 76, including the skilled artisans, the propriety of whose presence in this humble list is subject to serious question. It is to be remembered, however, that of the 192 as to whose extraction no information was available, many, perhaps the most, sprang from obscure lines, nor is it to be overlooked that among those mentioned as of distinguished ancestry 106 belonged to royal families and were therefore of a special class; but with all allowance made for these considerations the figures are sufficiently remarkable.

Hasty generalization, however, from these figures, may be dangerous. It may not be true that talent is transmitted from parent to child, nor may it be safe to say that the children of the lowly and uncultured lack the root of genius in their natures. The caste-system, from which America has always been free, but which only during the past few generations has loosened its hold upon the social and intellectual life of Europe, may be the responsible factor in the large number of ancestries which were noble or distinguished. It is possible that the native genius of the toiling classes was merely denied an avenue of expression in the social and industrial life inherited from the feudal ages.

An inquiry into the ancestries of the Americans in Prof. Cattell's table of names, and into those of all countries during the nineteenth century, lends no small semblance of plausibility to such a theory. Thus, of the thirty-one Americans in the thousand, seventeen were of obscure parentage, and only nine were of noteworthy descent, the remaining five being those as to whom no information was afforded by our authorities. So, of the sixty-five in the thousand born during the nineteenth century, twenty-eight were of obscure and twenty-seven of distinguished ancestry, while as to ten no data appears; though in connection with these figures it is important to remember that of the sixty-five no less than seventeen were Americans—a startling proportion, be it remarked, and a significant token of our leap forward to greatness among the peoples of the earth. Something like the same conclusion might be worked out of the figures as to the ancestries of the individuals in the thousand connected with the ministry of religion—the one profession in the gloomier ages to which access was measurably possible from the lower walks; for of the 105 individuals thus connected with religion—a remarkable proportion of the whole—thirty-two were of obscure and only forty-two of distinguished birth, while, as to no less than thirty, no information is available.

A comparison of the vocations of the parents with those of the offspring in our lists discovers some very curious and interesting statistics.

Of the 39 individuals in the thousand who were sons of clergymen 6 became poets, 7 miscellaneous prose writers, 2 historians, 7 philosphers, one a military character, 4 scientists, 7 clergymen, 2 physicians, 1 a painter, 1 a lawyer, 1 a monk, leaving no name to represent the professions of music, painting, and acting.

Of the 36 individuals who were the sons of lawyers, 8 became statesmen, 2 revolutionists, 5 poets, 2 painters, 5 miscellaneous prose writers, 2 jurists, 2 generals, 2 historians, 2 physicians, 2 novelists, 1 a scientist, 1 a navigator, 1 (!) a clergyman, 1 Lord Chancellor of England, leaving no name to represent the professions of music and acting.

Of the thirteen who were the sons of musical parents, 1 became a scientist, 4 musicians and musical composers, 3 painters, 1 a poet, 3 miscellaneous prose writers, 1 a jurist, but none became philosophers, statesmen, military generals or actors.

Of the 11 who were sons of physicians, 2 became physicians, 1 a poet, 2 philosophers, 2 patriots and revolutionists, 1 a physiologist and anatomist, 1 a painter, 1 president of the Greek Republic, 1 a novelist and none became a musician or actor.

Of the 43 who were the children of military men 2 became scientists, 2 philosophers, 9 military men, 1 the founder of Pennsylvania, 1 a mathematician, 8 kings and rulers, 5 novelists, 4 statesmen, 2 clergymen, 2 painters, 1 a musician, 2 poets, 1 a miscellaneous prose writer, 2 actors, 1 a conspirator and political theorist. The large place of the military in the ancestors of the world's eminent men and women needs little explanation, perhaps, seeing the conspicuous place held by the profession of arms in the history of mankind. Yet it is not without significance that among the 65 celebrated men of the nineteenth century, eight were children of military officers.

Of the 68 who were the sons of artisans 8 became poets, 6 philosophers, 3 military men, 2 navigators, 1 a diplomat, 9 painters, 2 scientists, 2 historians, 2 rulers, 1 a political writer, 6 miscelloneous prose writers, 3 statemen, 2 orators, 1 a religious reformer, 2 musical composers, 1 a financier, 1 a pope, 1 a theologian, 2 novelists, 1 a Girondist, 7 clergymen, 1 a revolutionist, 1 a jurisconsult, 1 an archeologist, 1 a legal reformer and 1 a monk.

Rarely, it would seem, does the son among the world's distinguished personages, pursue the father's vocation. On the contrary, the genius of the son appears to choose, as a rule, quite another field. It is plain that a prediction of the precise line of endeavor in which the son should achieve greatness would be impossible with the talents of the ancestor as the only guide.

Parents whose talents are purely intellectual seldom beget children whose greatness lies purely in the domain of the esthetic. The eighty-six ancestors who were clergymen, physicians and lawyers gave no musician to the world, nor any man or woman of histrionic genius, and but three painters. Their children attained distinction, like the parents, in the realm of the purely intellectual. Of those, who were the children of musicians, seven achieved distinction in music and painting.

* In discussing the contribution of the several classes of society to the world's great men, one factor which should not be lost sight of is the relative magnitude of each class. Thus, if we should find that a certain per cent of the world's great men were the sons of distinguished fathers, this does not enable us to judge correctly of the proportional share contributed by such distinguished fathers, unless we know what percentage of all fathers are distinguished. Thus if 1 per cent are so distinguished, and they furnish 50 per cent of all distinguished sons, this is a very high contribution, for the remaining 50 per cent are contributed by a much larger class —99 per cent—of fathers.—Editor.

Fig. 1.—Dense smoke passing through precipitator before current is turned on. The flow of gas is 900 cubic feet per minute.

Fig. 2.—Same as Fig. 1, with the current turned on. The smoke is seen disappearing above the apparatus.

Fig. 3.—Dense smoke is passing in at the bottom of the chamber, coming out clear at the top, as long as the current flows.

The Corona Method of Removing Smoke and Dust from Gasses

A Highly Efficient Form of Electrical Precipitation

By W. W. Strong

In almost every city, especially where manufacturing industries are attended by large volumes of smoke, the problem of abating the so-called smoke nuisance has proved not easy of solution. Especially has this been so in Pittsburgh, which has in the past been the source of many an atticism. However, due to the several methods, introduced within the last three or four years, of removing dust, smoke and fumes from gases, even Pittsburgh is approaching the clear skyline.

In many of the methods used for clearing smoke, a "point" or "edge" electrical discharge is used. A discharge of this kind is not uniformly distributed about the point or edge. The discharges cause a slight pressure in the gas and the smoke or fumes always seek that part of the apparatus where the discharge is weakest or entirely non-existent. Thus, it will be seen that the efficiency of the point or edge discharge process is greatly reduced.

The writer has made use of a corona type of discharge and has thus obtained a perfect radial symmetry of the discharge about the electrode. The negative corona is found to be more suitable since slight changes in the position of the corona electrode do not greatly affect the symmetry of the electrical discharges.

It is probable that this form of discharge is the most efficient application of the electrical method of removing fumes, smoke and dust from gases. The use of 300 watts will clean 800 to 1,000 cubic feet of the densest kind of smoke or fumes per minute, with a very small energy loss. The cleaning can be done by passing the gases through 4 feet, or even less, of the corona discharge. The voltage is about 28,000. (See "The Positive and Negative Corona and Electrical Precipitation," Proc. American Institute of Electrical Engineers, June, 1913.)

Referring to the accompanying illustrations, Fig. 1, shows dense, black smoke passing through the precipitating chamber, which is 4 feet high and 3 feet in diameter. About 900 cubic feet of smoke is passing through every minute, uninterrupted by current flow. Fig. 2 shows the same precipitating chamber in which the corona current was turned on only a second before the photograph was taken. At the top of the picture is seen part of the black smoke that was passing through before the current was turned on. The corona discharge cuts the smoke off "just like a knife." Although dense smoke is flowing into the precipitation chamber in Fig. 3, the smoke particles are aggregated and fall into a receptacle at the bottom. The precipitation continues to take place as long as the corona current flows, allowing only clear gas to pass into the air. An end view of the precipitation chamber taken at night, is shown in Fig. 4. This shows the electrodes covered over and completely hidden by the discharge from the corona current—a purple violet discharge somewhat similar to the northern light displays sometimes seen in the midnight sky.

Fig. 4.—Top view of precipitation chamber, taken at night, showing electrodes hidden by discharge.

With the rapid development of high tension apparatus, this method promises to be an important factor in abating smoke and the many kinds of dust and fumes of our cities. It is quite probable that the apparatus can be made to run automatically and can be so shielded that no one can come in contact with the high voltage currents.

This method of cleaning gases does not interfere with the draft to any appreciable extent, and it does not lower the temperature of the gases. It precipitates the dust, fumes or smoke in a practically pure state so that if they possess any value they can be very easily recovered. This method also produces a small quantity of ozone which assists in purifying the gases.

The Manufacture of Carbon Black from Natural Gas

An original method of power generation is in operation at Wilsonburg, W. Va., at the plant of a firm which manufactures carbon black. The product is obtained from the flames of natural gas by impingement on a smooth surface and final removal of the deposit by means of steel scrapers; it is used in the manufacture of printing ink and paint.

The natural gas is supplied from a well 3,000 feet deep and at a pressure of 950 pounds. Formerly this was led through a 4-inch main direct to the carbon buildings and the power necessary for driving the scrapers, etc., was obtained from a steam boiler and engine.

The management, however, conceived the idea of utilizing the initial pressure of the gas by passing it through the cylinders of the steam engine, the latter serving in the capacity of a reducing valve, and at the same time, doing away with the use of steam. Accordingly, the piping was arranged as shown in the sketch, a 2-inch branch being taken off the 4-inch gas main and led through a regulating valve to the engine. The exhaust is led into a discharge tank, a spreader being provided at the end of the exhaust pipe. From the discharge tank the gas passes through a 3-inch main to a clapper check valve, which works simultaneously with each chug of the exhaust and allows the gas to feed into the carbon buildings with constant regularity.

By using gas in place of steam in this manner, the engine is said to respond more quickly and more uniformly. Also, it not only provides free power, but reduces the labor by one man.—*The Journal of Industrial and Engineering Chemistry.*

Greatest User of Asbestos

If the United States can not boast of pre-eminence in asbestos production, as it can for many other minerals, it is at least a matter of some gratification to know that the bulk of the world's production comes from America and that the Canadian deposits yield by far the larger part of the total. In this, too, the United States benefits, for the nearness and reliability of the Canadian supply, largely owned in the United States, afford the basis for our eventual unquestioned supremacy in the development of asbestos manufactures. Even as it is, there are, according to J. S. Diller of the United States Geological Survey, some valuable deposits and promising prospects in the United States and these would undoubtedly be much more largely developed were it not for the extent of the Canadian deposits. The domestic production in 1912, according to Mr. Diller, was 4,403 short tons, valued at $87,959, and although this was a decline of 42 per cent in tonnage compared with the output for 1911, it was only 27 per cent less in value, owing to the larger quantity of higher-grade asbestos in 1912. Georgia, Vermont, and Wyoming are the three States which mine asbestos. The Canadian exports of asbestos in 1912 amounted to 88,008 tons, of which 71,426 tons, or more than 81 per cent, was imported into the United States. This quantity was 67 per cent of the entire Canadian production.

Asbestos is the most important fireproofing material known. Its fibrous structure adapts it to a wide range of applications—from woven fabrics, such as theater curtains and articles of clothing, to asbestos shingles, stucco, plaster, asbestos "wood," and various other forms of building material that render structures thoroughly fireproof.—*The Chemical Engineer.*

James Furman Kemp, professor of geology at Columbia University, New York.

Honored with the LL.D. of Toronto University: Profs. Sederholm, Chamberlin, Tchernikoff, Brock, Miller, and Ternier.

Hans Stille, professor of geology and director of earthquake station, Leipzig.

The Twelfth International Congress of Geology

The World's Coal Supply the Principal Topic for Discussion

[Photographs by the Dominion Photograph Co., Toronto, Canada.]

INTERNATIONAL CONGRESSES serve a number of purposes. The reading of papers, affording an opportunity to the members of bringing their work before an international audience, is one, but perhaps the least significant of these functions. Of much greater importance is the chance for direct personal discussion and interchange of ideas which such meetings bring with them. A third feature, which is of great value at all congresses, but which at a geological congress in particular brings incalculable benefits, is the arrangement for excursions covering a wide territory in a part of the world not otherwise readily accessible to many of the foreign members present. One need hardly be a geologist oneself to realize at least in some measure, what it must mean, for example, to a European geologist, to be able to witness with his own eyes some of the most important geological features of our continent, features with which he may have become in some degree familiar by reading, but with which only actual examination with his own eyes can render him fully conversant. And not only this, but in his study of such foreign geological territory he has, through the mediation of the congress, the most expert guides which our day has to offer. At the recent Twelfth International Congress of Geology held in Toronto during the week beginning August 7th, abundant facilities were offered for excursions of this character. The several trips may be divided into three sections, excursions arranged to take place before the meeting, covering Quebec and maritime provinces, Ontario (including the Sudbury District, Cobalt and Porcupine and many other points of special interest).

Secondly, during the meeting a number of short excursions covering the immediate vicinity of Toronto formed part of the programme.

Finally, for a period of over three weeks after the meeting, long range excursions extending as far as Alaska have been arranged for.

It has been the custom at geological congresses of the past to select some one special topic as the center of gravity for discussion at the congress. Three years ago, when the meeting took place at Stockholm, the subject selected was the iron resources of the world. This has been very appropriately followed in this year's congress by a discussion of the coal resources of the world, and the extensive data on this subject which have been collated by the world's eminent authorities in the different countries, have been published in a monograph accompanied by an excellent atlas.

In addition to the main subject mentioned above, seven other topics were placed on the programme for the special attention of the members. Numbering these in order, assigning number one to the subject of coal resources, we have the following list: (2) Differentiation of Igneous Magmas; (3) The Influence of Depth on the Character of Metalliferous Deposits; (4) Origin and Extent of the Precambrian Sedimentaries; (5) Subdivisions, Correlation and Terminology of the Precambrian; (6) To what Extent Was the Ice Age Broken by Interglacial Periods?; (7) The Physical and Faunal Characteristics of the Palaeozoic Seas, With Reference to the Value of the Recurrence of Seas in Establishing Geological Systems; (8) Miscellaneous.

Among the members attending the congress were many of the world's foremost geologists. The photographer was fortunate enough to obtain very excellent snapshots of some of these, from which the illustrations on this page were prepared. The names of these men are familiar to all working in the field of geology and it is unnecessary for us to dwell upon them at length. For those who are less familiar with this branch of science, the captions under the cuts will bear sufficient information.

On the left Prof. Wiegand (Germany). In the center Prof. Hubrecht (Java).

Our Debt to Pure Science

AT the recent opening of the new building of the National Physical Laboratory, Teddington, England, Mr. Balfour gave an interesting and thoughtful address dealing largely with the national advantages of the study of pure science. In the course of his address he remarked:

"Measuring is the very life-blood of physical science. It lies at the root of almost all great discoveries and their application to practice. It is impossible not to acknowledge the benefit which mankind has received by the command which science has given us; and measurements and testing are absolutely essential to science. The great features of a national laboratory are its impartiality, its ability to bring an adequate staff and adequate machinery to bear on problems, and the standard of perfection which it sets for instruments and which serves as an ideal for manufacturers to work to. The advantages to industry are beyond all doubt and beyond all question.

"But the successes of the future of industry depend on the abstract or purely scientific investigations of the present, and it is to the labors of the man of science working for purely scientific ends, and without any thought of the application of his doctrines to the practical needs of mankind, that mankind will be most indebted as time goes on. The general public does not realize that it is to the results of pure science that we have owed in the past, and shall owe more and more in the future, all great advances in industrial knowledge and practice. Still less does it realize that the man of science who is working continuously toward industrial ends is only half a man of science, and is not likely to do his scientific work nearly so well as if he were simply and solely occupied in advancing that branch of knowledge with which he is connected.—*Nature.*

On left, Dr. Kunz, gem expert, Tiffany & Company, New York. On right, Prof. A. La Croix (Paris).

On left, Sir Henry Miers, principal of London University. On right, Dr. Whitman Cross of United States Geological Survey.

The Seat of the Soul*

Views Held by Prominent Thinkers of the Past and Present

By David Fraser Harris, M.D., B.Sc.

It is well known to the historian of biology that even the plants have been supposed to possess souls.

The famous naturalist, Andrea Cæsalpinus (1519-1603), of Arezzo, who is even now regarded in Italy as the discoverer of the circulation of the blood, enters into a long discussion on the nature and seat of the plant-soul in his book, "De Plantis Libri," xvi. (Florence, 1583.)

We need not follow the subtle Cæsalpinus through all the details of his arguments as to where the soul of the plant must reside, but he finally places it at the junction between the root and the stem. This region, later known as the "collet" or neck, was, even after the time of Linnæus, regarded with a superstitious respect, as though here had been established some special focus of vitality.

The well-known man of science, the Burgundian Mariotte (died 1684), in his "Sur le Sujet des Plantes," declares that, as we know nothing about the vegetable soul, the assumption of it is not helpful in plant physiology.

If we go back far enough in the history of thought about the relations of the soul to a material substratum, we find that the seat of the mental processes was not originally supposed to be within the nervous system at all. The ancient Egyptians regarded the soul as seated in the heart, as also did Aristotle (B.C. 384-322), an idea by no means fantastic when we reflect on the ease and certainty with which emotional states influence the force and rate of the action of that organ. As late as the time of the Neapolitan philosopher Vico (1678-1774) this idea was revived, Vico insisting, contrary to Descartes, that the mind was in the heart and not in the head.

Aristotle, in particular, referred to the brain as "cold and bloodless," and imagined its function to be that of cooling vapors from the heart.

Another old Greek idea was that the mind or soul resided in the diaphragm, a reference to which still lingers in our own word phrensy (frenzy), which is derived from phren, the Greek work for the diaphragm. "Phreno-pathia" is a now little-used term for mental disease, and "phrenetic" means mentally excitable, while "phrenitis" has actually become a synonym for inflammation of the brain. Hence, the word "phrenology," a term for that pseudo-science which purports to be a discourse on the localization of things mental, is actually derived from a word which refers to the diaphragm, and neither to the brain nor the head at all. It is not difficult to see how the notion arose that the soul was resident in the diaphragm, since strong emotions, affections of the soul, strongly affect that great muscle so important in breathing. Emotions made the chest to heave visibly, therefore emotions arose or existed locally in the chest and in its chief muscle, the diaphragm, so the ancients argued.

From time immemorial has not the spleen been thought to be the seat of anger and envy? We even yet talk of a "splenetic" man and of a "fit of spleen" as meaning an angry man and a fit of anger. While Shakespeare undoubtedly accepted these notions on the visceral distribution of the emotions, placing love, for instance, in the liver, he had at the same time undoubtedly heard of the soul as seated in the brain, for he wrote in "King John" (Act V. Sc. 7):

"It is too late; the life of all his blood
Is touched corruptibly, and his pure brain
(Which some suppose the soul's frail dwelling-place)
Doth, by the idle comments that it makes,
Foretell the ending of mortality."

The early Belgian chemist van Helmont (1577-1644) was probably one of the last men of science to regard the soul as existing outside of the head; he placed it in the pylorus of the stomach. His reasons for this are very quaint reading: "Though it carries out sensations and movements by means of the brain and nerves, its actual throne is in the pylorus; it resides in the orifice of the stomach." In proof of this van Helmont says that a great emotion is always felt at the "pit of the stomach," and that "a man may have his head blown off by a cannon-ball and his heart continue to beat for some time, whereas a severe blow over the pit of the stomach will stop his heart and take away his consciousness simultaneously." But he qualifies this in the following subtle manner: "Though it is placed in a locality it is nevertheless not there in a local manner; it is present in the stomach in some such way as light is present in a burning wick."

Concurrently with these ideas regarding the extra-cranial seats of the soul, there had been schools of thought from the earliest times which regarded the central nervous system as that to which the mind was related. As long ago as about 300 B. C. Herophilus of Alexandria had imagined the soul to be inside the fluid of the cerebral ventricles, these innermost recesses of the entire body, the mental Holy of Holies. Herophilus regarded the fourth ventricle as particularly mental; this is very interesting to us, seeing that below that cavity some of the most important vital centers in the nervous system are undoubtedly situated. Claudius Galen (died 200 A. D.), to do him justice, taught that the brain was the place where the soul and intellect had their home.

We may pass over all the centuries intervening between Galen's death and the date of the publication of Vesalius' great work, the "De Corporis Humani Fabrica," 1543, because they contributed nothing toward clear thinking about the localization of mental attributes. The father of Anatomy (1514-1564), to whom physiological problems were by no means uninteresting, has the following prescient remarks on the mind as related to the brain: "But how the brain performs its functions in imagination, in reasoning, in thinking, or in memory (or in whatever way, following the dogmas of this or that man, you prefer to classify or name the several locations of the chief soul) I can form no opinion whatever. Nor do I think that anything more will be found out by anatomy or by the methods of those theologians who deny to brute animals all power of reasoning and indeed all the faculties belonging to what we call the chief soul. For as regards the structure of the brain the monkey, dog, horse, cat, and all quadrupeds which I have hitherto examined, and indeed all birds and many kinds of fish, resemble man in almost every particular. Nor do we by dissection come upon any difference which would indicate that the functions of those animals should be treated otherwise than those of man. In proportion to the size of the body, first the ape and then the dog exhibit a large brain, suggesting that animals excel in the size of their brains in proportion as they seem to be endowed with the faculties of the chief soul. I wonder at what I read in the scholastic theologians and the lay philosophers concerning the three ventricles with which they say the brain is supplied."

The particular views Vesalius could not accept were that the most anterior cavity in the brain was for sensations, the middle one for imagination and the posterior for memory; notions that had originated with the Arabian doctors and had been adopted by such scholars as Duns Scotus and Thomas Aquinas.

The next attempt to localize the soul and one that attained to a notoriety commensurate with its ingenuity was that by the Frenchman Réne Descartes. The great philosopher of Touraine placed the soul in the pineal gland. There was a show of reason for his choice of this local habitation; the soul, according to all current conception, had to be one and indivisible and not extended in space. No region of the body seemed so suitable for the seat of such an essence as the single, simple, not bilaterally developed pineal gland, the nearest approach to a single point which could be discovered in the central nervous system. Here, after the manner of a general governor or overseer, sat the soul, said Descartes, thither came information from all the senses to it, thence it issued its commands to all parts.

There was a dark side to Descartes' speculations, for his followers, denying the existence of a rational soul in the lower animals, taught that the members of the brute creation were unconscious automata. The practical outcome of this philosophical absurdity was that certain Cartesians treated the lower animals with positive cruelty. Very unfortunately for Descartes, when the pineal body came to be examined under the microscope, it was found to consist only of some atrophied cells and a few crystals of carbonate of lime and other earthy matter, a most unlikely dwelling-place for the soul, for "dust thou art, to dust returnest," was *not* spoken of the soul. Philosophy had to try again. We must next notice the views on this subject of a great Englishman, Thomas Willis, M. D., in his early life a pupil of Harvey. Though Willis wrote extensively on the nervous system, his views are not nearly so well known to the general reader as those of Descartes. Whereas, according to Descartes the soul was as nearly as possible an indivisible point which could exist only in an organ that was not even bilateral, for Willis there were two souls, each widely diffused, the one in the blood, the other in the nervous system. Willis asserted that the soul in the blood was of the nature of a flame, that in the nervous system of the nature of light. Willis's explanation of the way the soul (through its derived spirits) was related to the brain was somewhat as follows: "The lighter and more spirituous parts of the blood ascend by the arteries to the brain, where a distillation takes place, and animal spirits are the result. These spirits flow over the surface of the cerebrum and cerebellum, whence they descend all over the nervous system. Only the spirits in the cerebrum are destined for voluntary movement and sensation, those in the cerebellum are for involuntary movement." This last idea is interesting in the light of modern work, for although we cannot admit that, as stated, it represents the truth, still it is a fact that the activities of the cerebellum are carried on entirely outside the sphere of consciousness. Undoubtedly Willis had glimmerings that sensations and their memories, mental images, were on their physical aspect modifications of the substance of the brain. He talks of "the pictures or images of all sensible things admitted into these secret places." One of Willis's books is actually named "De Anima Brutorum" (concerning the soul of animals). The soul, then, was by Willis allowed to reside in the cerebral hemispheres, where it has ever since been permitted to rest in peace, at any rate on the part of those who believe that it needs a circumscribed dwelling within the bodily frame.

When we come to the brilliant young man of science, the Dane Nicholas Stensen (1638-1686), we come to the first attempt to express the modern notion of localization of function within the brain, a truth parodied by the phrenologists, believed in by the physiologists. This was how Stensen put it when writing of the fibers in the white core of nervous matter: "If, indeed, the white substance be wholly fibrous in nature, we must necessarily admit that the arrangement of its fibers is made according to some definite pattern, on which doubtless depends the diversity of sensations and movements. It is my opinion that the true method of dissection would be to trace the nervous filaments to the substance of the brain to see which way they pass and where they end; but this method is accompanied with so many difficulties that I know not whether we may hope ever to see it executed without a special method of preparing" (1662). We had to wait about 200 years for that special method.

The notions of a central soul and peripherally acting spirits in the nerves of the senses and in the motor nerves lingered for a long time in the minds of the learned. The closing lines of the "Principia" (1687) show that they were the working hypothesis of such an intellectual giant as Sir Isaac Newton.

A return to the idea of the soul as permeating the entire body was made by the famous German thinker, Georg Ernst Stahl (1660-1734), the originator of the unfortunate conception of phlogiston. Stahl spoke of an "anima sensitiva" which penetrated into and possessed every organ and tissue of the body. No tissue really living was outside the sphere of its immanence. The views of Stahl are alluded to as those of "Animism."

The modern statement of the problem has come to be: Is consciousness restricted to an association with cerebral activity, or does it also accompany activity of lower centers, including those of the spinal cord? Few biologists can now be found

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who uphold the doctrine that consciousness is awakened by activity of the spinal cord alone; all inferences from experimental work on the nervous system forbid such a conclusion. We cannot imagine that the decapitated snake with only its cord intact which coils itself round the red-hot poker is a conscious organism. On the contrary, it allows itself reflexly to be burnt up just because the seat of its consciousness, its brain, has been removed from the intelligent direction of its body.

As regards emotional and intellectual localization, the phrenologists have neither advanced nor retarded the scientific study of the material relationships of consciousness. John Joseph Gall (1758-1828), usually thought to be the founder of phrenology, originated neither the term itself nor the body of beliefs known by that name. The term was given by one Forster in 1815. Gall was imbued with the notion, correct, but in advance of his time, that certain mental attributes were localized in the cerebrum. He rightly supposed centers to exist for intelligent speech and for word-memories. Gall lectured on the functions of the cerebrum before various universities in Germany. His colleague, Spurtzheim, much less of a man of science and more of a popular lecturer, developed phrenology as we know it to-day. Its dogmas and absurdities are too well known and have been too long refuted to detain us now. But possibly some of us have little idea of the furore that phrenology caused in the early years of last century. The Phrenological Society of Edinburgh has 630 members, that of London 300, and a Chair of Phrenology was actually established at the Andersonian College in Glasgow.

The modern problem is not where the soul is seated, but what precise modification of cerebral tissue constitutes the physical concomitant of a mental process; that the two processes are intimately correlated no one doubts. Until lately, physiologists had been content to refer states of consciousness to states of activity of the bodies of the nerve-cells found inside the gray matter of the cortex of the cerebral hemispheres. But the physiological psychologist, Dr. MacDougal, of Oxford, has brought forward some evidence which points to certain delicate junctions between the processes of the one nerve-cell and those of another as being the actual seats of consciousness. The problem is one of interest entirely to the specialist, and one only to be solved by the specialist; but the broad fact remains that natural science knows of no mind as apart from matter, and only a very specialized kind of matter, as directly related to the existence and development of what we understand by mind.

Sources of Motor Fuel*

An Important Discussion at the British Motor Transportation Conference

A DOZEN years of propulsion by internal-combustion engines have practically sufficed to revolutionize the traffic on the roads, to create a traffic in the air, and to make man doubt whether he will long continue to make his sea journeys by "steamers." History hardly knows of any greater, more rapid change. At the end of the past century the future seemed to belong to electric propulsion, itself a new-comer. At the present time the electric locomotive successfully rivals the steam locomotive; but the motor-omnibus and vehicle threaten to oust both the local railway and the electric tramway, as they have driven the cart-horse and carriage-horse from the roads. The development has been astounding, and that implies, almost as a matter of course, that it has not been in all respects desirable. Life is endangered by the reckless speed of motor vehicles; our roads are smeared with oil, and the atmosphere is not free of noises and smells. But to check the automobile development at the present moment would be a graver matter than the endurance of its present defects. Yet a most formidable check seems to threaten the industry—the dearth of motor-fuel. More perhaps is being written just now on this subject than on any other. We do not deny the serious aspect of the question; but when we examine the problem, we think that the outlook is not so black as it is painted.

At the present time gasoline is practically the only motor-fuel which is being utilized. Gasoline is derived from various sources. Its chief source, however, is natural oil, and as petroleum is not found in all parts of the world—for instance, not in the United Kingdom—and as its stores are nowhere inexhaustible, the supply of motor fuel becomes at once a national and an imperial problem. It was from this standpoint that the (British) Imperial Motor Transport Conference recently approached the question, when discussing the supply of fuel for motor vehicles. Delegates from all parts of the Empire had assembled for this Conference under the presidency of Prince Arthur of Connaught. Two technical papers were submitted to that meeting on "The Supply of Hydrocarbon Motor Fuels," by Mr. W. J. A. Butterfield, M.A., F.I.C., and on "Gasoline Substitutes," by Sir Boverton Redwood, Bart., and Prof. Vivian B. Lewes. We will review the technical side of the problem with reference to these papers.

Motor spirit may be defined as any easily-evaporated combustible liquid sufficiently volatile to form an explosive mixture with air at moderate temperature. That definition of Sir Boverton Redwood's would include gasoline proper—the portion of crude petroleum which distills over below 120 deg. Cent. and has a specific gravity of less than 0.75—as well as many other liquids, all hydrocarbons of various compositions. They may belong to diverse series—to the paraffin series, of the general formula $C_n H_{2n+2}$, the lowest member of which is the gas methane, CH_4, and the higher members of which are the solid paraffins, while those containing from four to eight atoms of carbon are the most suitable motor fuel. They may be the corresponding members of the olefine series of the general formula $C_n H_{2n}$. They may be the first three members of the aromatic hydrocarbons distinguished by a ring structure, the first member of which is benzol, C_6H_6. These latter occur in commercial benzol, by which term Mr. Butterfield designates a substance of which 90 or 50 per cent (the ordinary commercial grades) will distill over below 100 deg. Cent., and which would essentially consist of benzol, and further of its homologues, toluene and xylene. In their chemical properties these hydrocarbons differ widely from one another. But there is not much difference as to calorific power, volume for volume, and as to the range of suitable temperatures, a commercial benzol may, indeed, fractionate on distillation exactly as a standard gasoline. What is essential for all these spirits, and particularly also for the substitute later to be mentioned—alcohol and its denaturants—is a certain purity and freedom from sulphur and nitrogen compounds, which are of offensive smell and likely to yield during combustion products which would corrode the cylinders.

The imports of gasoline proper into England have risen from 18 million gallons in 1905 to 80 million gallons in 1912, the chief producing countries being the Dutch East Indies (which supplied 46 million gallons last year), America (16), Russia (5), Roumania (4), and other countries (9 million gallons). Five years ago America was still the chief source, and the relative proportions will probably be changed once more in favor of the United States this year. The total production of oil last year is estimated at 50 million tons; one tenth of that may be gasoline, in which the East Indian and Roumanian oils are particularly rich, and the 80 million gallons mentioned would, according to Sir B. Redwood, represent 2½ per cent of the world's supply of gasoline. Not included in these estimates are the vapors of pentane and hexane which generally escape with the natural gas (chiefly methane) from oil wells; these vapors are now condensed, and in the Oklahoma and Kansas fields 12,500 gallons of a very light spirit are said to be daily recovered in this way, and mixed with heavier grades. These heavier oils are in the first instance lamp oils or kerosenes of density about 0.8; they are mixed with 40 per cent of gasoline, and can be burned in special carbureters. The carbureter has hardly received the serious attention it deserves, though some types give excellent results. Yet such mixtures do not possess the elasticity required for congested traffic, with hot days and cold nights. Hence, when they are used for motor traffic, a supplementary gasoline-tank is provided for starting the motor and running until the machinery is warm, when the mixture from the main tank is turned on.

"Cracking" affords other means of utilizing oils not directly suitable as motor fuels. Cracked or heated hydrocarbons break up completely; some split into lower, lighter carbon (soot) and hydrogen, others split up into hydrocarbons. Here the influence of the chemical constitution and series comes in. Acetylene and benzol cannot well be cracked, because they decompose completely; the paraffins can be cracked by distillation and condensation under high pressure, especially in the presence of catalytic agents like nickel. Cracking by more or less secret processes is also applied to products derived from other sources than petroleum, to which we now pass.

The chief other raw materials already utilized are shale oil and bituminous and cannel coal. The British Empire is well stocked with these, and the delegates from New South Wales did not fail to draw attention to their oil shales during the discussion. Both there and in Scotland the distillation of shale was at first chiefly carried on for the production of lamp-oils, with lubricants, heavy gas-oils, paraffin wax, and ammonia as by-products. Very little motor spirit was then gained. Of late, cracking of the oil has been applied at high temperatures, steam and hydrogen being introduced at some stage. Thus the yield of motor-fuel has been raised to 60 per cent by volume of the crude oil treated. But the method in itself, and the revivification of the catalytic agents, are expensive, and the economy of most processes largely depends upon the amount of ammonium sulphate produced. This applies, at any rate, to Scotland, where Mr. Butterfield considers yields of 12 pounds or 15 pounds of ammonium sulphate, and of 25 or 30 gallons of crude oil per ton of shale distilled, as averages. The New South Wales shales are much richer in oil, and the prospects of motor spirit there better.

As regards coal-tar, we may broadly distinguish between coal distillation above 800 deg. Cent., as carried on in ordinary gas-works working with horizontal or inclined retorts, and distillation at lower temperatures in vertical and chamber retorts. The higher the temperature, the more the tar will be benzenoid in character—that is to say, it will consist of benzol and its homologues and other aromatic substances, such as carbolic and cresylic acids, naphthalene, anthracene, and pitch. The aromatic bodies we mentioned already cannot profitably be cracked. But benzol and toluene can be obtained by direct distillation; the remaining oil may be distilled through high columns of hot coke. The costs of the latter cracking process are rather prohibitive, however, and since only the largest works distill their tar, the 15 million tons of coal which are carbonized per year in ordinary gas works would not supply more than 50,000 gallons of motor spirit. In vertical retorts a large portion of the tar is distilled at low temperature, and remains paraffinoid, especially if the temperature does not rise to 500 deg. Cent.; up to 3 gallons of benzol per ton of coal carbonized are claimed to be gained in this way. But this yield would be quite inadequate to make the process remunerative. Cracking the naphtha distillate is also proposed or practised. The gas itself is not treated for the extraction of motor spirit. It may probably be done with a gain of another 3 gallons of motor spirit. The gas would, of course, be impoverished as an illuminant by being deprived of those constituents which make the flame luminous; this might necessitate legislation, but gas should not be burnt in naked flames, and gas works might face the expenditure for the necessary plant to scrub the gas.

The heavy, low-temperature, carbonization tars and coal-oils from bituminous coal and cannel may be both distilled and cracked, and the total yield of motor spirit from bituminous coal may rise to 7 gallons per ton. Whether that will be remunerative will be decided by the value of the coke produced, and again by the other chief by-product, the ammonium sulphate. Sir Boverton Redwood estimates that 8 million gallons of benzol are produced per annum by some such coke-oven process, and most of this material, if not exported, is wanted for other purposes. In any case, the 8 million gallons only make up a small portion of the 100 million gallons of motor spirit which, it is surmised, will be wanted this year. Mr. Butterfield thinks about 30 million gallons might be gained by scrubbing the gas of its benzol, and that the shale-oils might contribute about the same number of gallons. Part of this, however, would mean diverting a considerable portion of products from useful purposes, for which they are at present needed.

Sir B. Redwood, Prof. V. Lewes, and other speakers accentuated the fact that the stores of the chief raw materials—petroleum, coal, and oil shale—are in process of depletion; that is, of course, unassailable, and must not be lost sight of, though we should hardly assert with Sir B. Redwood that those processes which led to the formation of petroleum in the laboratory of Nature are no longer in active operation. We know very little of what is going on in the earth; there are not more than two boreholes which penetrate to a depth of one mile; and nobody doubts that new petroleum fields will be discovered. We do not for one moment wish to damp the zeal of those who insist on guarding the natural resources; but the argument of depletion must not be pushed too far in a particular direction. Whatever development industry and chemical engineering take, petroleum as

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well as coal and oil shales will be consumed in some manner, and the task of the present generation is to watch that nothing is wasted, and all by-products are utilized.

Now there are more direct ways than those so far alluded to of utilizing the coal-tar oils and other coal products and the petroleum products, and this reflection leads us to a wider view of the whole problem, even if we leave Diesel engines out of consideration. Mr. Butterfield emphasized, as already indicated, that if it be acknowledged that coal gas is essentially a fuel—also in the incandescent burner—and no longer a direct illuminant, hydrocarbons are not wanted in gas. Mr. A. W. Southey suggested that an adequate supply of motor fuel could be obtained from coal-tar oil, which he defined as a liquid product of the manufacture of a partially-coked fuel from bituminous coal, the fuel produced being suitable for the domestic grate. There is much to be said in favor of this proposal. The first question for the case under discussion is, of course, whether these oils can be made directly combustible in motors. That this can be done for commercial transport vehicles, at any rate, by suitable carbureters or gas-producers, is beyond question.

These points deserve attention, especially in view of the advance of the Diesel engine. The conference was, however, distinctly in favor of settling whether alcohol would not really prove a reliable motor fuel, preferable to those in use because it can be continuously manufactured in any quantity. Sir Boverton Redwood had concluded his remarks—the papers we have mentioned were taken as read—by recommending alcohol. He did not consider alcohol an ideal fuel under existing conditions, but said there was ample justification for trying it; their first efforts should be directed toward designing a motor and carbureter especially suited for alcohol; these difficulties would be overcome, and there would be no difficulty in obtaining the alcohol fuel at an adequate price. It was the last point—the supply of the fuel—which interested the Colonial delegates more particularly. They were all fully aware of the vast importance that the development of motor propulsion had for them. Speaking on behalf of the South African Agricultural Union, Mr. Oscar Evans, of Johannesburg, said that they could probably make alcohol from maize and other plants, and they would be perfectly prepared to put their hands into their pockets to find out what was the stumbling-block in the use of alcohol as motor fuel. This statement, and the readiness to assist in research, was re-echoed by other delegates. Mr. Gill, of Ceylon, saw in alcohol a solution of several Eastern difficulties, and delegates from British Columbia and New South Wales believed that they could promise pecuniary assistance for an inquiry into the manufacture of alcohol in the first instance apparently. But when Colonel Crompton had reminded the meeting that, while experiments demonstrated that alcohol could be used as motor spirit, they did not prove that the experimenters liked to use it, and that if funds were to be raised, they should have manufacturers of engines on the commission to investigate the root of the trouble with alcohol, the meeting adopted, *nem. con.*, the following resolution: "Having regard to the high price of gasoline, the limited quantities of petroleum, coal, and oil shales available, and the obvious fact that all these sources of hydrocarbons are in process of depletion, it is desirable that attention be given to the construction of motors for alcohol fuel, and that concurrently action should be taken with a view to the ultimate creation of an adequate supply of this fuel obtainable at sufficiently low price."

There is no doubt that alcohol motors can compete with gasoline motors; but there is a hitch somewhere.

It may be merely that the proper alcohol motor has not yet been constructed; it may be the corrosion trouble; it may be that, with present alcohol prices, it does not seem to justify manufacturers risking much money on prolonged costly experiments. If the Colonies and Governments step in with money grants, that difficulty will vanish. Whenever alcohol is discussed, the excise question arises. At present excise stands in the way, of course. But Mr. Tyrer pointed out to the meeting that when it had been proved to the Government years ago that British manufacturers could not, on foreign and colonial markets, compete with their German colleagues in pharmaceutical products and perfumes, a way out of the difficulty was found by refunding the excise paid, and a similar expedient might again be found. After all, the outlook is not so bad. In spite of all checks the development of the gasoline motor has been amazing. Lord Crewe pointed out in his opening remarks that Napoleon, when crossing the Alps, had practically to rely on the means of transport which Hannibal had at his disposal two thousand years previously. Printing and telegraphy have revolutionized the world, but at much slower rate than the gasoline motor. "Cracking" is only in its infancy; the engineer as yet seldom applies gas under pressure, and alcohol certainly can attain a reasonable efficiency in motor cylinders. Thus it would seem that there is an abundance of room for development along these lines.

Industrial Methods of Bending Wood

BENDING wood for furniture, especially chairs, is in reality an art in itself, and deserves some notice, if but brief. Nearly all types of lumber have the faculty which permits them to be bent into all sorts of shapes, so that they can be used in a variety of ways. Nevertheless, it is important for the skilled workman to know what kinds are best for his purpose.

CHOICE OF THE LUMBER.

Lumber which shows crooked and irregular growth is obviously not as well fitted for bending as lumber which has a straight grain and is well grown. The ground from which the timber was originally taken has also its influence, and in the case of beech and ash, the lumber best for our purpose, the differences may range from 1 to 30 per cent, depending on the ground from which the timber was taken. But even timber with irregular growth and full of knots can be bent, if treated properly.

Detailed investigations show the various kinds of wood to have certain factors which we may call the strength of flexure, and which is determined by supporting a square piece of wood at the ends, and then loading it to the breaking-point. These experiments are exhibited as follows: Maple, 7.20 to 10.90; birch, 5.20 to 9.60; oak, 4.20 to 12.20; ash (German), 7.80 to 11.90; ash (American), 4.30 to 7.80; pine, 6.30 to 7.98; linden, 6.80 to 8.10; mahogany, 6.40 to 7.30; hickory, 5.13 to 8.10; red beech, 6.40 to 9.85; fir, 4.50 to 6.40; elm, 4.65 to 11.80; white beech, 10.01 to 12.50.

The bending strength, or flexure alone, is not sufficient; the volumetric change of which the tree is capable must be taken into account, for the fibers of the wood must be able to readjust themselves to the new conditions arising in the process of bending. Since nearly every wood contracts during drying twice as much in the direction of the annular rings as is the case in the direction of the medullary rays, it is clear that wood will bend best in this direction.

Another reason which forces us to bend the wood in a direction at right angles to the medullary rays is the fact that wood bent parallel to these rays splits easily. Care must then be taken to bend the wood in the proper direction. Red beech contracts in the medullary direction 2.3 to 6 per cent, in the annular ring direction 5 to 10.4 per cent. With oak, these figures are 1.2 to 7.4 and 2.6 to 10.8 per cent respectively. If, then, these woods can undergo such a change when merely drying, it stands to reason that they will go through similar changes when bending.

PREPARING THE STOCK.

Dry lumber, from which all moisture has been withdrawn, is harder to bend than green, or semi-dry, lumber. In these cases the lumber must be treated with heat and steam, in order to loosen up the pores and widen them for bending. The length of the steaming process depends on whether the lumber has been air-dried for a long time, and whether the dimensions are large or small, for thicker lumber requires more time of steam application than thin wood.

It is also possible to bend wood without steaming it first, by using the high heat of a jet flame, as found in soldering-lamps. The wood is first preheated, which is best done by soaking it for some time in hot water. If sufficient water penetrates into the wood, the bending process is aided, since the water particles are finely divided by the flame of the jet, and equalize stresses, and, at the same time, prevent abnormal friction, thus distributing the heat evenly, and preventing scorching of the wood. This process is used extensively in the manufacture of canes; but it requires great care.

The best process is probably the treatment with steam. The steam must have at least 0.2 to 2.1 atmospheric pressure for this purpose. Special types of small boilers can be used where the ordinary boiler is not at hand, and as these require very little watching, and are economical in water consumption, since the returning condensed water is used over and over again, they are very simple and effective.

SATISFACTORY STEAMING.

The length of the steaming vessels depends on the length of the lumber to be treated. It is advisable to tip them somewhat toward the rear, so that the condensed water can escape toward that end, and so that the front of the vessel which forms a door will close automatically. Several grates in the vessel serve to hold the wood, which is then acted upon on all sides by the steam.

Success in bending depends on the speed with which it is accomplished after steaming. The bending-machine should, therefore, stand right next to the steaming apparatus.

Conditions for proper steaming can be ascertained by striking the floor with the ends of the piece in question. It should give a muffled, cork-like tone. If the wood has cooled too much, or is not steamed enough, it will give a clear, hard sound, showing that the wood is still hard and a good conductor of sound, while the steamed wood contains a large quantity of water-bubbles that dampen transmission of sound.

STRUCTURE OF THE WOOD.

To what a high degree the wood may contract its fibers is shown by these figures: A cane or umbrella-handle of 0.8-inch cross-section, if bent in a radius of 3.3 inches, has an inner circumference of 10.2 inches, and an outer circumference of 15.1 inches. If we distribute this difference on a radius, i. e., divide by two, we get a difference in length of 2.5 inches, which is the contraction which the handle has to undergo in bending.

Bending-machines are used only in wood of considerable thickness, as most wood can be bent by hand. With the proper leverage, a 3 horse-power force can be sufficient to bend even the strongest piece of wood. For furniture, the larger shops use presses and machines if for no other reason than to get uniformity in results. Even the smaller shop could use patterns, or forms of wood or iron, coated with some rust- and heat-proof paint, to good advantage. It is important to have a rust-proof paint on the metal patterns, for otherwise the wood will show rust stains that are almost impossible to remove.

DRYING THE WOOD AFTER BENDING.

After bending, the wood must be dried at once, so that it will retain its new shape. The drying process must proceed slowly until all hygroscopic water has been driven off and the wood has regained the proper balance of internal structure, and has resumed its natural strength and due position of fibers.—*Deutsche Tischler-Zeitung.*

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